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ABSTRACT

This study compared the effects of a formal, an open-framework, and a control preschool program on children's intellectual development. The formal program, based on Ausubel's and Piaget's theories, had a daily schedule of short prescriptive teaching sessions followed by related learning activities. The informal program, based on Piaget's theory, relied on teachers to stimulate the children to assume self-initiated activity rather than to provide direct instruction. The control program was a traditional play-oriented approach not based on any particular theory of intellectual development. Pre- and post-testing were done with the Peabody Picture Vocabulary Test, the Raven Coloured Progressive Matrices Test, and a series of logical concept tasks assessing relations, classification, and conservation. At midyear, a sample of children from each experimental group was assessed with a battery of classification and conservation tasks which, unlike the pre- and post-tests, included content selected by teachers from the learning materials in their programs. A delayed post-test was administered to the Ausubelian and control groups but not to the Piagetian group due to its excessive subject attrition. Based on the overall results, it was concluded that both experimental models were superior to conventional preschool programs in enhancing the growth of logical concept attainment and that the Ausubelian model was more effective in facilitating development of such concepts in the short run. (Author/JMB)

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Technical Report No. 462

A COMPARISON OF THREE EARLY CHILDHOOD INSTRUCTIONAL PROGRAMS

by

Joseph Lawton, Frank Hooper, Ruth Saunders, and Priscilla Roth

Report from the Project on
Studies of Instructional Programming for the Individual Student

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Faculty Associates

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ABSTRACT

The first phase of a longitudinal study comparing the effects of both a formal and open-framework educational program on the intellectual development of young children was completed during 1975-1976 at the University of Wisconsin Preschool Laboratory.

The formal preschool program is based primarily on Ausubel's theory of learning and in part on Piaget's developmental theory. The daily schedule has a related series of short prescriptive teaching sessions in the form of "advance organizers," followed by related learning activities. A major emphasis is placed on sequential transfer. Distinctions are made between subject matter concepts and process concepts. The latter are identified as "logical operations" as described by Piaget. The informal program is based on Piaget's theory of development; specifically, the preoperational and concrete-operational stages. The teacher assumes an interactive role with both child and learning materials aimed at prompting the child to assume self-initiated activity. Content is selected for its potentiality to promote learning behavior leading to the construction of mental operations. No attempt is made to directly teach logical operations. These two programs were also compared to a "control" preschool program in the local community. The control program is not based on any particular theory of intellectual development. Primary assessment measures included two standardized indices (The Peabody

Picture Vocabulary Test, Forms A and B, and The Raven Coloured Progressive Matrices Test), and a series of logical concept tasks assessing relations (transitive inference, seriation, and multiple seriation), classification (dichotomous sorting, some-all, class inclusion, and multiple classification) and conservation (number, length, surface area, weight, internal, occupied and compensatory/displacement volume). At midyear a battery of short-term summative assessment tasks of classification and conservation were administered to a sample of 12 children from both experimental groups. In each case, the sample represented teacher assessments of high, average, and low achievers (according to teacher evaluations). Unlike the neutral content of pre- and posttests, these tasks included content selected by teachers from the learning materials in both programs respectively. Each primary task had two subtasks using content from both programs. A time interval of 6 to 7 months separated the identical pretest and posttest. A delayed posttest was administered to children in the Ausubelian and "control" preschool programs 4 to 5 months after completion of the posttests. All tasks were individually administered to 55 subjects (27 males and 28 females) including 18 children in the Ausubelian classroom ($\bar{X}$ age at time of pretesting = 49.7 months), 17 children in the Piagetian classroom ($\bar{X}$ age = 51.4 months), and 20 children in the traditional classroom ($\bar{X}$ age = 48.95 months).

Primary data analyses consisted of a series of MANOVA and ANOVA comparisons with two major contrasts: (a) combined experimental conditions versus control subjects and (b) the Ausubelian condition versus

the Piagetian condition. Pretest MANOVA analyses indicated a general absence of significant differences (exceptions included total seriation, weight, and length conservation scores). Posttest MANOVA comparisons indicated experimental group superiority for seriation, dichotomous sorting, and multiple classification, and conservation of number, weight, and interior volume. The Ausubelian children were superior to their Piagetian counterparts on number, length, and weight conservation tasks. No significant sex or sex/treatment interactions were found. ANOVA comparisons with time of measurement as the within-subjects factor indicated significant time effects for all measures except multiple classification, interior volume, and occupied volume. Contrasts favoring the Ausubelian program were significant for conservation of weight and occupied volume while the Piagetian children were superior on the RCPMT. Experimental/control contrast interactions with time of assessment were significant for the RCPMT, number conservation, sorting, and total seriation scores.

Delayed posttest ANOVA comparisons indicated Ausubelian group superiority on class inclusion, multiple classification, additive seriation, serial correspondence, and conservation of number, weight, interior, and occupied volume compared to the control group. No comparisons were made with the Piagetian group at this time due to excessive attrition in this group.

ANOVA comparisons on interim year test data indicated that: (a) Ausubelian program children were generally superior to those in the Piagetian program on classification (notably, class inclusion) and conservation tasks; (b) there were no significant differences in performance between first and second versions of each task; and (c) although there was absence of variability between task means for the Ausubelian

group there were significant differences for the Piagetian group.

A task relations analysis (principal components analysis with Varimax rotation) on posttest data produced four clear-cut factors: conservation, relations, classification, and a final factor contributed to solely by transitivity. Given the limitations of factor analysis procedures with these data, a clear four-dimensional structure emerges. This result lends some support to the argument which opposes the "structure-of-the-whole" concept.

Since children had been required to provide justification responses following judgmental statements on conservation tasks, and since there is some controversy over the advisability of whether or not to ask for explanations, a descriptive analysis of the conservation tasks justification data was carried out. The results indicated that: (a) judgments are often made on irrelevant data; (b) more than one basis of comparison may be used to make judgments; (c) the most likely justification to an incorrect judgment is an inversion/reciprocity or empirical return argument; (d) children tend to progress through levels of adequacy; (e) statements of logical compensation can be reasoned from any justification type; (f) the more abstract the task the more likely an inversion/reciprocity argument will be used; and (g) when making judgments about quantity the addition/subtraction argument is very effective.

It was concluded that both experimental models are superior to conventional preschool programs in enhancing the growth of logical concept attainment. The Ausubelian model appeared more effective in facilitating development of such concepts in the short-run.

I

A longitudinal study, intended to be conducted from the fall of 1975 to the summer of 1980, was set up at the University of Wisconsin Preschool Laboratory to study the effects of both a formal and open framework education program on the intellectual development of young children.

The study was designed in three parts. The first phase was scheduled to begin in the fall of 1975 and to be completed in October 1976. During the following year, 1976-1977, curricula, classroom organization, and the construction of the test-battery would be analyzed and revised wherever it was considered necessary, based on the results of the first phase. Also, research was planned for this second phase, aimed at (a) identifying more clearly the differences between the two preschool programs, and (b) measuring differences between teacher and child language use in small group, large group, and one-to-one learning situations. The results of this research, during the second phase of the longitudinal study, will be reported elsewhere (see Lawton & Brown, Note 1).

The third phase of the study was begun in the fall of 1977. At this time, there was a new intake of preschool children aged 2-1/2 to 3-1/2 years. A commitment has been sought from parents to allow their child to remain with the research project for 3 years.

Formal and Enrichment Programs

Elkind has discussed at some length the pros and cons of what he has termed formal and enrichment programs (e.g., Elkind, 1970, 1973, 1976). He tends to oppose the notion that academic instruction is more economic and efficient than the more usually informal and traditional

preschool programs. However, he also admits (Elkind, 1973) there is, as yet, no longitudinal evidence to help answer the question: instruction or enrichment for middle-class preschool education?

The case for structural learning experiences is generally made in relation to the disadvantaged child as a needed alternative to the supposed disorganized environment in which such children live (e.g., Bereiter & Englemann, 1966; Landreth, 1972; Weikert, Note 2). Advocates of open-ended early childhood education programs have also described these mainly in terms of the disadvantaged child (e.g., Weikert, 1967; Kamii & Radin, 1967). Programs for disadvantaged children have primarily been aimed at improving intellectual functioning to enable the children to remain in the public school system. For those children who are expected to get sufficient instruction at home, it has been suggested the preschool can provide needed enrichment kinds of experiences. The advocates of a formal, academic type of instruction (e.g., Berlyne, 1965; Hunt, 1961; Sava, 1968; Bushell, 1973) generally argue that some type of formally structured program is necessary for disadvantaged children during the early years. It is argued that without external structuring of the learning environment the young child is incapable of handling the diversity of information provided in enrichment programs in an efficient manner.

Moerk (1977) states that, with reference to learning in general, but specifically in connection with language learning, a child left to his own devices would face an overwhelmingly difficult task. In most cases, it is also stated that the emphasis should be on intellectual

development without implying a lack of concern for affective and physical development. White (1975) makes out a strong case for certain types of intervention (an organized environment to promote infant development) or instruction during the first 3 years of life. He claims these are crucial years for early and later development and that, obviously, the responsibility for promoting the infant's development rests with parents. White suggests that, if parents are effective as educators, there is little need for preschool except that it might provide enrichment experiences not within the scope of the home. There would be little disagreement with this proposition except that the educative family is an anachronism. There has been considerable skepticism shown regarding the efficiency of the modern family as an "educational" environment (e.g., Almy, 1975; Lovas, 1973; White, 1975).

A study that will surely make an important impact on educational thinking is that by Bennett (1977). It is primarily concerned with teaching styles and pupil progress for children aged about 4-1/2 to 10 years. Bennett compares the effects of formal and informal teaching on children's learning. The results can be briefly summarized. Pupils in formal classrooms improved considerably more in their achievement than the less formally taught. Most pupil types, irrespective of personality progressed better under formal teaching. Such teaching significantly favored the insecure and neurotic child. Children in informal settings did no better on creative activities than those in more formal settings. We must keep in mind the children in this study were past preschool. However, as Bruner points out in the foreword to the Bennett book, research

on the preschool child has shown that,

> One of the best known ways of increasing the young child's capacity to concentrate attention over large periods of time is to have adults close by who can serve as 'scaffold' to the child . . . once the child has experienced these protected deeper forays into the world, he will increasingly prolong his attention . . . [Bennett, 1977, p. xi].

Bennett identifies 12 teaching styles from most informal to most formal. In general, formality involves expository teaching, identification of content, sequential organization, group work where groups are decided by the teacher, and a controlled amount of pupil-directed activity. Informality favors an integration of subject matter, an emphasis on process rather than content, children's choice of activities (whether individually or in groups), much free movement, and little formal assessment. The most important emphasis, perhaps, is on intrinsic motivation.

A plea is made by Bennett not to naively assume there is a clear polarity between teaching styles, or that the results suggest that a polarity should be envisaged with proponents from both camps throwing brickbats at each other.

It is quite clear that no strong case can be presented for an either/or position. As Mayer (1971) has pointed out, the structure of a program applies not to any single dimension but to the interrelationships of parts in a complex entity. She describes interrelationships in terms of possible varieties of modes and the frequency of interactions between teacher, child, and material. It is suggested that the influence a particular program has on learning is not determined by the idiosyncratic elements of the program, but rather by the nature of the child's interactions with them. As Bruner also states in Bennett's book, "We are only at the beginning of under-

standing how a curriculum equips a learner with the skills and attitudes and values that make him richer, stronger and more critically self-reliant [Bennett, 1977, p. xii]."

What about the general elements of both preschool programs in this study (see Lawton, Lewis, & Deibert, 1976, and Ershler, McAllister, & Saunders, 1977)? First, intellectual development is described in terms of Piaget's theory. Very briefly, Piaget has described intelligence as the incorporation of given data of experiences into an organized intellectual framework. Development of intelligence is expected to occur through interaction between the child and the environment. Learning and development are active processes involving manipulative and exploratory interaction with concrete objects and events. Intellectual development is expected to occur in a series of stages characterized by specific cognitive operations, the stages appearing in an invariant sequence. The cognitive operations developed by preschool-aged children are those Piaget associates with the later preoperational and early concrete-operational stages of development (see Inhelder & Piaget, 1964). Emerging operations include classification, seriation, and conservation. The skill to classify is needed to form concepts; that of seriation to arrange objects in order along some dimension (e.g., long to short, wide to thin, many to few, etc.); and that of conservation to reason that, though certain properties of objects are changed, if nothing is added to or taken away from an object, certain properties of the object (e.g., weight, length, volume, area) remains the same. Thus, if, for example, a length of paper is cut into sections and the sections separated from each other, the length of the paper re-

mains the same. For Piaget, such operations characterize intelligence, and they are expected to develop over a long period of time (from about age 2-3 years to age 10-12 years). Thus, although it can be expected that some children will begin to develop classification, the use of "all" and "some," and dichotomous sorting within the preschool years (about 3-5 years), operations such as class inclusion (comparing sub- and superordinate groupings in a hierarchy of related classes) can only be expected to be fully developed much later. Piaget has provided us with a developmental theory. It has been left to others to attempt to apply the theory to preschool program procedures. Where this has occurred (e.g., Kamii & DeVries, 1977; Furth, 1970) the programs have been informal in their organization.

Ausubel (e.g., 1963; Ausubel, Novak, & Hanesian, 1978) suggest that cognitive structure is comprised of concepts and propositions (learned from various subject matter areas) arranged in hierarchical structures. In teaching children it is advised that suitable subject matter be organized into a sequence with general ideas taught first and then related to more specific concepts and factual information which are taught second. This arrangement is expected to provide the potential for meaningful learning to occur. That is, new knowledge can be related nonarbitrarily to established ideas previously learned. This way of learning is expected to reduce rote learning and enhance long-term memory. Ausubel acknowledges that the way the young child processes information is different from that of the adult. He distinguishes between three stages of intellectual development; preoperational, concrete-operational, and formal-abstract. The preoperational stage covers the late preschool and early elementary grades of schooling. In accord with this theory, the crucial factor in providing

information during the school years would be to provide adequate concrete examples of all concepts introduced, and make the learning active. However, it is important to note that Ausubel does not distinguish between subject-matter concepts and process concepts (see Piaget's notion of operations). In the Ausubelian Program a distinction has been made between both types of concepts, and they are taught hand-in-hand. Unlike the Piagetian Program, the Ausubelian Program aims to enhance intellectual development in the short-run and within the context of both subject-matter and intellectual-operations areas.

The basic aims of the first phase of this longitudinal study are twofold: (a) to measure the effects of three types of preschool program (Ausubelian, Piagetian, Learning-Through-Play or Traditional) on young children's cognitive development during the course of a single school year, as measured by an array of Piagetian-type tasks; and, (b) to measure the relatively short-run effect on performance of the Ausubelian and Piagetian programs, with special reference to curriculum content.

The next chapter describes, in some detail, the basic principles upon which each program was based, including the control group program in a community preschool.

II

THREE PRESCHOOL PROGRAMS

The Piagetian Program

For the Piagetian program (informal/open-structure) the emphasis in classroom organization is on stimulating cognitive growth in conjunction with an equal emphasis on social-emotional and physical development, while ensuring a growth of knowledge through actions. An overemphasis on representation is deprecated and is expected to hinder the "spontaneous" development of the child. The spontaneity of action and its necessary relation to both mental and physical action should be encouraged by the teacher.

This program is characterized by considerable flexibility within a carefully planned environment. The theory was used to define implicit structure in the activities made available to children and in teacher plans for interaction. The emphasis in learning situations is on each child's active involvement with concrete objects and particular experiences so that he will generate a system to explain the world around him. In short, the child constructs his own knowledge in response to the changing demands of the physical environment, of his peers, and of the questions and thought-provoking comments of the teacher(s).

Basic Premises for Development

The program is guided by the premise that although logical thought processes are acquired as the individual matures, they should not directly be taught. The child constructs modes of reasoning through the process of reflective abstraction. This includes (a) his own attempts to resolve

discrepancies between his way of thinking and feedback from encounters with the environment, and (b) attempts to resolve internal discrepancies or inconsistencies in his system of thought. The major impetus for development comes from the child's intolerance of discrepancies. When the child becomes aware of a discrepancy, he is obligated to work towards resolving it. Environmental variables which enhance developmental progression, then, are those which make children aware of either type of discrepancy. Such variables include aspects both of the physical environment and of the social environment.

In addition, since the consistency of the child's system is important, developmental changes are assumed to involve global reform rather than the addition of single facts or abilities. Development will not necessarily be a linear process. Rather, it will show periods of progression and regression as a particular system is refined and then abandoned in an attempt to find a better one (which in turn is first refined and then supplanted by another). This follows from Piaget's conception of the stage transition process as representing alternating periods of stability and instability or stage mixture (see also Werner's concept of "spirality," e.g., Langer, 1969, 1970; Werner, 1957; Werner & Kaplan, 1963). In addition, Piaget distinguishes among the various forms of knowledge and the potential role of direct instruction associated with each form. Physical and social knowledge forms are amenable to direct instruction. In contrast, logicomathematical knowledge is dependent on the reflective abstraction process and requires self-initiated action schemes for optimal development. In this case the teacher may serve as

a facilitator but not as a source of specific information.

In the Piagetian system language is viewed as an instrument of thought and as a useful medium for expressing thought. Language can help certain modes of thought become more efficient, but it cannot help the child develop those modes (except in its communicative role for pointing out discrepancies).

Classroom Organization

The following is a typical schedule for the Piagetian Program.

Activity	Approximate amount of time
Greeting	15 min.
Class meeting (whole group)	15 min.
Small groups (four or five children with one teacher)	15 min.
Free rotation (children choose activities)	60 min.
Clean up	15 min.
Large group	20 min.
Preparation for departure	10 min.

Each complete session is about 3-1/2 hours.

The classroom is divided into the following well-defined areas: art (both expressive art and product-oriented activities), quiet activities (small manipulative materials, books, table toys, small construction toys, games), science and reading, active play (blocks, water play, work bench), dramatic play, snack area and cooking activities, and an outside area for large motor activities. Each area is prepared with

materials that provide challenges for children at various developmental levels.

Content

Content in this program reflects specific interests of both children and teachers. An effort has been made to find out children's interests and use them as a basis for planning. Teacher ideas, based on a knowledge of current environmental experiences and long-term educational goals are also used in conjunction with children's interests.

Particular Intellectual Abilities Emphasized

Although all three areas of knowledge as defined by Piaget's theory--areas of logico-mathematical, physical, and social knowledge (e.g., see Ershler et al., 1977; Kamii & DeVries, 1977)--are noted in program construction, emphasis is on classification, seriation, spatio-temporal understandings, and physical knowledge.

Relationship Between Intellectual Processes and Content

Intellectual processes may be theoretically distinguished from content, but psychologically, one always accompanies the other. The program reflects this point by dealing with process and content simultaneously. Because of the theoretical claim that development involves a nonlinear change in the system of thought, neither process nor content (nor, for that matter, their interaction) is sequenced, except in a very general way.

Approach

The major approach to children's acquisition of content and reasoning processes is one of guided discovery and provoked invention. Teachers use questions, comments, and materials to help children construct for

themselves systems of ordering, grouping, recognizing invariant aspects of variable objects, and finding specific properties of the physical environment. Reception learning (as defined below) is present, though infrequent.

Teacher's Role

The teacher's main concern is to encourage the expression of differing opinions, ask provocative questions, and encourage the kind of exploration expected to lead the child to the construction of rules and to the generation of theories to account for how the world responds to his interactions with it.

This involves a good deal of planning with specification of (a) the kinds of materials likely to elicit variety of actions and careful observation of the results of those actions, (b) questions likely to provide cognitive conflicts for children at various developmental levels and with different amounts of exposure to the content involved, and (c) ways to augment children's expressions of and awareness of differing opinions.

Child's Role

Children in the Piagetian programs are encouraged to initiate activities, to actively explore the classroom environment (varying their actions and paying close attention to the results), to generate possible rules for how things work, and to engage in the kind of social interaction which requires joint problem solving.

Formative Evaluation

Formative evaluation is an integral component of this program. In addition to informal anecdotal records, one staff member is assigned to observe each day and, depending on the day, to record a particular child's behavior, general uses of areas of the room and/or materials, theoretical

interpretations of children's behavior, or the integration of activities. Written records made for the daily small group sessions include an assessment of children's behavior as related to the goals for the activities. Formative evaluations are used extensively in day-to-day planning. Because the effectiveness of particular teacher strategies depended on each child's developmental level, knowledge of each child's progress is vital and is carefully integrated into plans.

The Ausubelian Program

In the Ausubelian (formal structure) program the main approach to teaching is primarily expository, and learning is primarily receptive. It is important to make clear, however, that child-directed activities are included and that account is taken of children's contributions to the various learning episodes. The expository teaching/meaningful reception emphasis is based on Ausubel's theory of meaningful learning. Ausubel places a major emphasis on the pedagogic facilitating of transfer (e.g., Ausubel & Robinson, 1969, p. 142). Ideas must be identified in subject-matter which are "proximately inclusive"; that is, their level of generality or inclusiveness places them just above the level of abstraction of concepts and specific facts in subsequent learning tasks. These ideas are presented first as "advance organizer" lessons. When learned they are expected to provide a potentially meaningful set of "anchoring" ideas under which the subsequently presented nonarbitrary new learning material may be subsumed (emphasis is added to make it clear that no guarantee for meaningful learning can be assumed by adopting this approach). A detailed account of the possible contribution of Ausubel's learning theory to pre-

school education has been presented earlier (i.e., Lawton et al., 1976).

Basic Premises for Development

The Ausubelian program is based on the prediction that logical thought processes, as well as subject matter concepts, propositions can be directly taught which are durable in memory and which have particular types of transfer value. In this study, transfer is described in terms of near-near, near-far, and far-far transfer (e.g., Beilin, 1971b; Brainerd, 1974). Where learning on one task (e.g., spontaneous classification) transfers to a similar task, that would be near-near transfer; learning on, say spontaneous classification which transfers to another type of classificatory task such as class-inclusion (or, more likely, vice versa) would be an example of near-far transfer; where learning in, say classification (class-inclusion) transfers to another type of operation such as conservation, that is termed, far-far transfer. It is the first two types of transfer that are more highly predicted for the Ausubelian program.

Experience in learning relatively high-level subject matter concepts or high-order rules, presented verbally and accompanied by concrete exemplars during advance organizer lessons, must be followed by many and varied related learning activities. These subsequent learning activities provide extensive concrete concept exemplars in the learning materials. It is this sequence of related learning experiences which is expected to promote meaningful learning, retention, and transfer.

Language is expected to promote development. But children must learn, as efficiently as possible in the presence of concrete objects and events, the referents for concept labels, and rules which govern the

reasoning of causal explanation and logical justification.

Classroom Organization

The Ausubelian timetable is typically organized as follows:

Activity	Approximate amount of time
Child directed activities: free choice within certain limits	15 min.
First advance organized sessions in small groups (four or five children with one teacher)	15-20 min.
Related activities (small groups of individuals working alone or with teacher--activities are teacher-child directed)	15-30 min.
Snack time	15 min.
Second advance organized sessions (as above)	15-20 min.
Related activities (as above)	15-30 min.
Clean up	10 min.
Large group	15-20 min.
Preparation for departure	10-15 min.

Each complete session is about 3-1/2 hours.

The classroom and adjoining areas are divided into areas for small and large group activities. It is easier to define areas for the reader by describing program content.

Content and Intellectual Skills

Knowledge is described in terms of both subject matter and process concepts. Flavell (1970, p. 991) has pointed out that a distinction can be made between the classes a subject knows and what he knows about class. The teaching of both types of concept is initially kept separate and then taught hand-in-hand. The separation appears necessary on occasions to emphasize one or the other. The long-term aim is to promote an understanding of the interdependence of both.

Subject matter areas chosen are those considered consistent within the child's present environmental experiences. For example, the "science" of living and nonliving things. Other areas include math, social studies (social-emotional concepts, comparisons of communities, etc.), language, art, music, movement, socio-drama, and so on. In each case, a task-analysis approach is used to identify basic conceptual structures and their interrelationships. The hierarchical arrangement of concepts determines to some extent the sequence of presentation.

Second, intellectual skills have been identified within the logico-mathematical knowledge categories described by Piaget. Unlike the Piagetian doctrine which claims that logico-mathematical concepts are not directly teachable, the position taken for the Ausubelian preschool program supposes such skills can be taught as high-order rules generalizable to classes of related problems.

Approach and Teacher's Role

The main approach to teaching is expository. In each advance organizer lesson (AO) a limited number of relatively high-order subject

matter, or process concepts are taught. Each is accompanied by a number of concrete examples. The teacher uses a combination of direct, and indirect questions and statements. The lessons are couched in story form or proceed as games (see Appendix B for an example of both lesson types). These lessons are always followed by related activities (RA). Each AO will have a series of RAs related to it which provide specific detailed examples of each concept or idea initially presented in the AO. RAs are sometimes simple problem solving situations which require the application of previously learned concepts. These activities are a combination of teacher and child directed activities. As children become more familiar with the system they are encouraged to help organize these activities or even suggest similar activities they are solely responsible for. Overall control and direction, however, remains in the hands of the teacher. The child's role is implicit in the above description. It must be emphasized that the child is not an inactive recipient of ready made knowledge. There is no emphasis on rote learning. It is accepted that the child will bring to each learning situation personal and idiosyncratic ways of learning and interpreting information. However, at the same time, the teacher also attempts to make it clear that, in order to communicate and work together, some common ground for communication and expression must be established. This is just as obvious a necessity in peer group social interaction.

Formative Evaluation

Formative evaluation is a necessary part of the program. Detailed records are kept of each child's progress in intellectual, affective,

and physical areas. Informal, anecdotal information is also used. These records are used for daily planning, to assess whether or not each child is reaching criterion level of learning with respect to each type of concept and to regulate the organization of the curriculum sequence, small group, large group, and individual learning activities. Although this program uses a small group instructional approach, much individually guided instruction occurs based on the records from formative assessment.

The Learning-Through-Play Program: Traditional Program

Type of Program

This program is a flexible one in keeping with the view that children learn best when free to choose their own activities and to follow their own lines of interest within an activity. Stress is on each child's playful encounters with concrete materials and experiences. Teacher interactions are designed to provide emotional support for the child's activity, to provide a model of sociably acceptable interactions, and to put into words what the child is doing, feeling, or thinking (in so far as it is possible for the adult to infer what is going on in the child's mental world).

Basic Premises for Development

The Learning-through-play program is an eclectic model with an emphasis on the importance of play. Principles of development are not explicitly stated, but self-motivated play, an emotionally supportive environment, and the encouragement of creative expression are clearly expected to contribute to the child's development.

Active involvement with concrete materials is considered extremely

important. Language is taught through modeling--i.e., verbalizations describing what the child is already doing or has already understood. The major principle for developing cognitive skills is that simple materials be introduced before complex ones.

Classroom Organization

Typically this program's schedule is organized as follows:

Activity	Approximate amount of time
Large group	15 min.
Free time (children choose activities)	65 min.
Clean-up	10 min.
Snack (whole group activity)	15 min.
Music and rhythms (whole group)	15 min.
Free play outdoors	30 min.

Each complete session is about 3-1/2 hours.

Classrooms are divided into well-defined areas, particularly areas for: blocks, art work, books, small manipulative toys, sensory materials (sand, water, etc.), and large motor activities (outside). Available materials and activities change from simple to complex as the school year progresses. Children are helped to use materials for a variety of different purposes.

Content

The content in each classroom is chosen and sequenced by the individual teachers. Particular attention is paid to attributes of the physical environment (size, shape, color, weight, and texture), number skills, and the expressive arts (music, stories, dramatic play, and

art work).

Particular Intellectual Abilities Emphasized

Intellectual abilities are largely defined in terms of content. There is some emphasis, in the use of free play activities, however, on the ability to try various solutions, to concentrate, to think with a purpose, and to make decisions.

Approach

The approach in this program varies from unguided discovery within an emotionally supportive free play environment to teacher-initiated reception learning in group activities. Children's free explorations with the environment are not explicitly guided by teacher comments or questions. Some sequence is provided by the kinds of materials and activities made available throughout the year, but teachers generally concentrate on responding to whatever children are doing--i.e., verbalizing experiences as they occur.

Teacher's Role

The teacher's main functions in this program are to maintain a supportive emotional atmosphere, to offer a variety of experiences in keeping with diverse learning styles, and to sequence content in keeping with the simple-to-complex order presumed to enhance children's developing abilities. During free play, teachers help children get involved in play, verbalize what children are doing, and help to resolve problems in social interaction.

Child's Role

Children are expected to meet the social demands of group activities

and to become actively involved in play experiences of their own choosing. The intensity of involvement and the length of time spent in an activity are used as indicators of effective use of the play method. Signs of progress include a decrease in the amount of teacher help required in play and an increase in interactions with other children.

Formative Evaluation

Formative evaluation is largely anecdotal. Teachers keep records on individual children and refer to these records in planning activities and in assessing the effectiveness of the program. The evaluation reflects the eclectic approach of child-development oriented preschools so that expectations for motor development, cognitive skill acquisition, language, etc. are drawn from a variety of sources, depending on each teacher's training.

III

REVIEW OF RELEVANT LITERATURE

Reviews of studies related to both Piaget's and Ausubel's theories will be presented in that order.

Piagetian Research

Classification

Exhaustively sorting objects and events into mutually exclusive classes is an ability that supposedly develops quite late in the period of preoperations. True or complete classification, according to Piaget (e.g., Inhelder and Piaget, 1964) includes both an understanding of hierarchical class-structure and class inclusion relations. The latter is considered a crucial measure of the development of concrete operations. Class inclusion involves the comparison of sub- and superordinate classes within a hierarchy of classes. Cross-classification, a multiplication of classes, requires the child to organize objects into subclasses by considering concurrently two properties. The arrangement of subclasses can be described in terms of both systems of organization at the same time, which requires that the child coordinate both the intensive and extensive properties of the objects or events.

The developmental sequence in classification, as described by Inhelder and Piaget (1964), has in general been substantiated (e.g., Elkind, 1961; Hood, 1962; Kofsky, 1966; Lovell, Mitchell, & Everett, 1962; Smedslund, 1964), although some discrepancies have been found (e.g., Hooper, Sipple, Goldman, & Swinton, in press; Lawton, 1977; Lawton & Wanska, 1978; Lovell,

1961; Lovell & Ogilvie, 1960; Overton & Brodzinsky, 1972).

Variation in performance for both inter- and intratask arrays may be partially accounted for by factors such as methodological problems, task or materials complexity, instructional set, etc. A number of studies have investigated the effect of instructional set and task format variation on class inclusion performance. With respect to task format, Wohlwill (1968) and Wohlwill and Katz (Note 3) found that a verbal rather than pictorial presentation enhanced performance. Winer (1974) and Winer and Kronberg (1974) replicated these findings, though Jennings (1970) and Swartz (1971) found the reverse to be the case. Perceptual cues have been found to influence performance (e.g., Ahr & Youniss, 1970). In this case it was discovered that incorrect judgments increased as members of subordinate classes increased. Brainerd and Kaszor (1974) found no support for these findings. Investigators have also found that class inclusion questions are sometimes misinterpreted (e.g., Ahr & Youniss, 1970; Klahr & Wallace, 1972; Siegel, (Note 4).

An important methodological issue that applies not only to class-inclusion tasks but all Piagetian-type tasks is whether judgments alone or judgments-plus-explanation is the appropriate criterion for assessing the presence of a particular cognitive structure. Brainerd (1977) has argued that, from a Piagetian perspective, judgments and explanations measure the same cognitive structure. Explanations require language, not considered to be an intrinsic part of thought. Therefore, explanation can be considered a sufficient but not necessary condition for determining the existence of a structure. Brainerd also argued that explanations are open to Type II error, while judgments are not subject to any systematic

type of error. Reese and Schack (1974) choose to disagree with this explanation. They argue that judgments are not immune to sources of error and that explanations are not necessarily always subject to Type II error. In this present study, explanations were required but precaution was taken to reduce the possibility of interpretation error.

Seriation

The ability to arrange objects in an ordered series along a particular dimension determined by some property (e.g., length, width, color, sound), is expected to occur during the preoperation period. Piaget & Szeminska (1952) have defined the order of seriation development as follows. First, the child is only able to deal with a limited number of items and arrange them into limited series of two or three. Second, the child proceeds by trial and error to complete a large series of items but cannot add members into a completed arrangement. Finally, without much ado, the child completes series, is able to add items to such an arrangement, knows that individual items can be smaller than and larger than other items in a series (i.e., reversibility), and put two series in a one-to-one correspondence. Elkind (1964) replicated Piaget's original findings, though Siegel (Note 4) reported that only the very young children in her study (aged 3 years) responded at the lowest level (preoperational) thus raising the question of a truly preoperational stage of seriation development. Seriation has more often been studied in relation to the synchronous development of intellectual skills. While some studies (e.g., Lovell et al., 1962; Smedslund, 1964) have found interrelationships between classification and relational skills consistent with those

of Inhelder and Piaget (1964) several studies have found nonunitary development (e.g., Berzonsky, 1971; Brainerd, 1972; Chittenden, 1964; Lagattuta, 1970; Nassafat, 1963; and Wohlwill, Fusaro, & Devoe, Note 5). Most of these studies were cross-sectional. It appears likely that a wide divergence of measurement instrument design and complexity and also scoring criteria contributed to the inconclusive picture that emerges from this comparison.

Cross Classification and Double Seriation

Both these skills involve the ability to sort objects on two variables simultaneously. The usual measurement instrument for assessing these skills is a matrix. Theoretically, according to Piaget and Inhelder (1969), multiple orderings, hierarchical classification (including class inclusion), and seriation should emerge at about the same time. In keeping with previous discussion of the synchrony (a structures-of-the-whole) question (e.g., Beilin, 1971a, 1971b; Brainerd, 1973; Hooper, Goldman, Storck, & Burke, 1971), the results are equivocal.

In cross-classification studies a usual range of behavior from randomized placing of elements to ordering on one dimension and finally on both dimensions has been observed (e.g., Bruner & Kenney, 1966). This is also the case with cross-seriation, as a combination of both (e.g., Mackay, Fraser, & Ross, 1970; Hooper & Sipple, Note 6).

Conservation

Piaget and Inhelder (1969) have identified conservation as the understanding that although objects may undergo transformations, certain properties can remain unchanged. It is expected that the young child will

find conservation difficult due to an overemphasis on the use of perceptual cues or imagined configuration. Conservation of substance is supposed to develop prior to that of weight which is followed by an understanding of conservation of volume. Although Lovell and Ogilvie (1960) confirmed Piaget's prediction of a three-stage development from nonconservation, through partial to complete conservation spanning the years from about 6-7 to 10, variability of responses due to task complexity, materials complexity, and task format has been reported (e.g., Lovell & Ogilvie, 1961; Murray, 1969; Rothenberg, 1969; Schwartz & Scholnick, 1970).

Training Studies Related to Piaget's Theory

The majority of the experimental attempts to elicit or accelerate logical concept abilities have dealt with conservation tasks. With few exceptions the studies conducted prior to 1965 demonstrated a general lack of significant training effects (Flavell, 1963), while later studies have usually shown specific transfer effects. The possibility of intermediate and far-transfer effects which are stable appears to be a complex joint outcome of the developmental status of the target children (transitional children outperform their younger counterparts), the type of instructional procedure employed (structured, didactic approaches are generally more efficacious than self-discovery programs), and the complexity of task arrays used (see reviews by Beilin, 1971a, 1976; Brainerd, 1973, 1977; Brainerd & Allen, 1971; Strauss, 1972). Attempts to train classification skills have met with varying degrees of success dependent upon the type of training procedure used, the developmental

level of subjects, and type of transfer assessed (see reviews by Beilin, 1971a, 1976; Klausmeier & Hooper, 1974). Studies such as those conducted by Morf (1959) and Kohnstamm (1963, 1967), though finding varying degrees of learning improvement, provide no clear identification of the factors most likely to be responsible for the improvement. Studies such as those by Brainerd (e.g., 1973, 1974) more precisely identify the training source to which can be attributed learning improvement. Training has generally been unsuccessful when measured by performance on far transfer tasks, though Inhelder, Sinclair, and Bovet (1974) did find improvement on conservation performance following class inclusion training.

Training procedures attempting to improve performance on multiple classification and seriation tasks have generally been less successful than those dealing with additive classification (e.g., Clarke, Cooper, & Clark, 1967; Clarke, Cooper, & Loudon, 1969; Moskovitz, 1971; Sigel & Olmstead, 1970; Shantz & Sigel, Note 7).

Using a posttest only design, Hooper (1972) evaluated classification and seriation training procedures with 3-1/2 to 4-1/2 year old children in small group instructional settings. Classification training proved unsuccessful and neither training procedure produced transfer to conservation performance. These results were substantially replicated in a later study with 4 to 5 year old children (Bingham-Newman & Hooper, 1974).

Parker, Rieff, and Sperr (1971) trained 6 to 7-1/2 year old children on a multiple classification program, with some success related to performance on color/form matrices. Similar results were obtained in a further study (Parker, Sperr, & Rieff, 1972). In this later study there

were no far transfer effects.

Resnick, Siegel, and Kresh (1971) and Caruso and Resnick (1972) trained children to use double classification skills using a task analysis approach. They found that (a) learning an easier task in a hierarchy did transfer to learning a more complex task, but that (b) subjects mastering the more complex task first acquired the less complex skill in the process.

Initial studies by Jacobs (1966) and Jacobs and Vandeventer (1968) where they attempted to train children on Raven Colored Progressive Matrices Test items reported no training effects. In two later studies (Jacobs & Vandeventer, 1971a, 1971b), an individualized training procedure was used on easily labelled stimuli varying in color and shape. In both cases positive transfer of learning was observed.

Various training approaches, in general, have produced specific transfer effects. In some cases limited far transfer has also been achieved. Training procedures involving multiple strategies in the content of a normal range of environmental experiences have usually proven to be the most successful. Unfortunately, under such conditions it becomes almost impossible to pinpoint which factor(s) is most responsible for producing improvement. Obviously further research is required to either attempt to replicate previously successful teaching approaches or to isolate factors and test their individual power.

Training Studies Related to Ausubel's Theory

Ausubel (1963) and Ausubel, Novak, & Hanesian, (1978) have proposed that the acquisition of prior "organizers," within the content

of meaningful verbal learning, influences the meaningful learning and retention of subsequently presented learning materials. Organizer lessons teach ideas or principles (rules) at a general level which is proximate to related, more specific concepts and factual information that will be learned later. Ausubel does not distinguish between subject matter and process concepts. It has been suggested (e.g., Scandura, 1977) that knowing the content structure of subject matter is not equivalent to specifying the relevant competencies the individual requires to understand that structure. A distinction has been made between subject matter and process concepts (e.g., Lawton, 1977; Lawton & Wanska, 1977).

Most of the research on advance organizer (AO) effect has been conducted with college students and children at the elementary school level. Original studies (e.g., Ausubel, 1960; Ausubel & Fitzgerald, 1961, 1962) and secondary studies (e.g., Allen, 1970; Gtotelueschen & Sjogren, 1968; Lawton, 1977a, 1977b, in press; Scandura & Wells, 1967; Steinbrink, 1971; Weisberg, 1970) have found positive training effects in favor of AO groups. Other studies (e.g., Clawson & Barnes, 1973; Caponecchi, 1973; Sowder, Musser, Flora, & Bright, 1973; Woodward, 1967) report no facilitating effects. The weight of evidence, however, supports the facilitative effect of AOs as predicted by Ausubel.

In a recent study (Lawton & Wanska, Note 8), a clear distinction was made between content AOs and process AOs. It was found that AOs which combined both high-order content and process concepts produced the most significant learning effects followed by the process AO and content AO,

in that order.

The study reported here is the first of its kind to use AO lessons with preschool children.

IV

METHODS AND PROCEDURES

Experimental Design

This study was scheduled as an exploratory first phase of a planned longitudinal study. The design involved the following components:

1. the pretesting and posttesting of three groups of children exposed to different types of preschool programming--a Piagetian approach (P), a traditional play-oriented approach (TPO), and an Ausubelian approach (A),

2. the interim testing of the P and A groups (the TPO group was excluded from this assessment because of constraints on time and equipment), and

3. the delayed posttesting of the A and TPO groups (delayed posttests could not be given for the P group because of considerable subject attrition in that group).

All subjects were pretested shortly after entry to the program in the fall of 1975, and posttested in May 1976. The interim tests were completed during January 1975. Delayed posttests were administered in October 1976. The experimental design is presented in Table 1. Further details on design can be found under subsequent sections where each component is discussed separately.

Treatment

The two treatment groups at the preschool lab attended for 3 hours per day, 4 days per week, while the community preschool group attended

Table 1

Experimental Design

Group time	Pretest	Interim Test	Posttest	Delayed Posttest
Piagetian	Sep-Oct 1975	Dec-Jan 1975-76	Apr-May 1976	
Ausubelian	Sep-Oct 1975	Dec-Jan 1975-76	Apr-May 1976	Sep-Oct 1976
Traditional	Sep-Oct 1975		Apr-May 1976	Sep-Oct 1976

Table 2

Distribution of Three Contrast Groups by Program, Mean Age, Mean Peabody Picture Vocabulary, And Mean Raven Coloured Progressive Matrices Test Scores

Program Subjects	N	Mean Age (Months)	SD	Mean PPVT[a]	SD	Mean RCPM[b]	SD
Ausubelian	17	51.4	5.68	57.12	8.99	14.00	4.00
Piagetian	18	49.7	5.91	55.17	5.42	11.17	3.17
Traditional	20	48.95	6.13	52.15	6.02	13.20	3.89

[a]PPVT: Peabody Picture Vocabulary Test.

[b]RCPM: Raven Coloured Progressive Matrices Test.

3 hours per day, 5 days per week. Major differences between the three contrast programs have been provided in Chapter II. Briefly, differences centered around the following variables: (a) the use of particular theories to establish principles on which the program is based; (b) teacher and child role in the classroom; (c) the structure and function of small group, large group and individual learning activities; (d) the selection, organization and sequencing of curriculum materials and related learning episodes; and (e) the nature and function of formative evaluation.

Pre- And Posttest Procedures

Subjects

A total of 60 three and four year old children from Madison, Wisconsin were recruited for the study with the intention of comparing three groups of 20 children each. Two of the groups (P and A) attended the University Preschool Laboratory. Children for these groups were selected from all applicants to the school semirandomly, i.e., random selection was constrained somewhat by parents' wishes for morning or afternoon sessions and by the desire to get two comparable age groups. The TPO group was composed of those children from a community preschool whose ages were comparable to those of children in the P and A groups. Children were drawn from four different classrooms in that school. In general, the children were from middle and upper-middle class families and predominately, though not exclusively, white. Table 2 shows subject variables for the three groups.

Test Materials and Task Descriptions

Measures. The following measures were administered at both times of

assessment (for protocols, see Appendix B):

1. The Peabody Picture Vocabulary Test (PPVT).

2. The Raven Coloured Progressive Matrices Test (RCPM). This was administered in the standard way except that testing was stopped after a child had made three consecutive errors. Our experience was that children rapidly lost interest after that point, gave only chance responses, and left the testing room unhappy with the whole situation. For this reason the modification in standard procedures seemed justified.

3. A dichotomous sorting task based on the classification tasks developed by Kamii (1971) and Kamii and Peper (Note 9). Children are asked to sort 22 blocks varying in color, shape, and size (two choices for each dimension) into two boxes and are scored both according to the consistency with which they sort and the number of different ways they sort the blocks.

4. A some/all classification task which was a modified version of that used by Hooper et al. (i.e., Hooper, Sipple, Goldman, & Swinton, 1978).

5. A class inclusion task based on the work of Kofsky (1966) and Brainerd and Kaszor (1974). Two sections of this task were differentiated according to the presence or absence of semantic cues. One section asked children to compare relations among families and family members. The other made use of relations among groups and subgroups of amorphous "blobs."

6. Multiplicative classification (cross classification). This task was a modification of the matrix task originally used in the work of Inhelder and Piaget (1964), Bruner and Kenney (1966), and MacKay et

al. (1970). Further refinements as described in Sipple and Hooper (1976) were introduced to provide a cross-classified array of cylinders (as used in the traditional double series task) with height held constant in each row and diameter within each column. The tasks required children to coordinate color and shape similarities on a 3 x 3 matrix board.

7. Multiplicative seriation (cross-seriation). This task was drawn from the same sources as 6. above and required the child to coordinate height and diameter gradations in a 3 x 3 matrix format.

8. Transitive inference using length (Brainerd, 1972).

9. Serial ordering, additive seriation, and serial correspondence. These tasks are basically those used by Bingham-Newman, Saunders, and Hooper (1976) with changes in materials (from sticks and circles to worms and apples) and a few changes in instruction to make the task more appealing to preschool children. (See also Bingham-Newman & Hooper, 1974; Coxford, 1964; Elkind, 1964; and Whiteman, 1964.) Children were asked to arrange a set of seven "apples" into the series (additive seriation), and to find the right-sized "worm" (of seven "worms" graduated in length) to match various "apples" in the series (serial correspondence).

10. Conservation of number. This task, adapted from Rothenberg and Orost (1969) involved judgments and explanations concerning sets of nine pennies in various configurations.

11. Conservation of weight. This task was a modified version of that discussed in Brainerd (1972) and required children to make judgments about the relative weights of balls of play dough when one was transformed

into a pancake and then into a sausage shape.

12. Conservation of surface area. This task was a modification of that used by Lovell, Healey, and Rowland (1962). Children were asked about the relative amounts of grass on two fields when barns were placed on the fields in different configurations.

13. Conservation of length--the standard task as used by Brainerd (1972).

14. Three conservation of volume tasks adapted with rather extensive modifications from Lovell and Oglivie (1961) were conservation of interior, occupied, and displaced volume. All of the conservation tasks followed a similar format. Children were asked three versions of the same yes/no question in random order. For example, on the conservation of area task (Part A) children were asked, "Now does this cow have the same amount of grass to eat as that one?"; "Does this cow (barns in a row) have more to eat than this one?"; "Does this cow (barns scattered) have more to eat than this one?". After the first of such questions the child seemed to have difficulty expressing his thoughts, nonverbally. Justification requests were repeated after each yes/no question until the child had given an adequate justification. No further justifications were requested after this point because it tended to prolong the task unnecessarily and to confuse children who were sure of their responses but not sure of how to deal with an adult's repeated requests for what they felt had already been given. Justification requests followed this general format: "How do you know?" or "Could you show me why?" followed, (if the child gave an incorrect answer), by a request such as, "Could you make it so they both have the same amount of grass to eat?". The

last request was included to check for *renversabilite* in young children who have a partial grasp of the problem.

A similar procedure was used for the class inclusion task (yes/no questions followed by justification requests) and the dichotomous sorting task (requests for the child to sort the blocks followed by a request for an explanation of the sort made).

The task materials and the format for administration were based on revisions and extensions of previously established procedures (e.g., Bingham-Newman et al., 1976) which had been shown to provide comfortable and interesting experiences for young children and which revealed a range of abilities found at the preoperational and early concrete operational levels of development.

Task Administration

Two task administration orders designed to counterbalance task order effects and yet maintain the interest and cooperation of children were randomly assigned to the children in each group and balanced across sex and treatment groups. Each subject was given the same task order for both pre- and posttests. The orders of presentation are identified in Table 3. Testing was conducted in 15-minute sessions over a period of about 6 weeks at each time of testing (fall and spring). Each task was introduced in a game-like atmosphere and involved a warm-up procedure before the task items were introduced.

Scoring

Task performances were scored in two ways: (a) primary responses,

Table 3

Orders of Presentation For Pre- And Posttests

A	B
1. Classification, transitivity	1. Relations
2. Conservation: Area, weight	2. Conservation: Area, weight
3. Relations	3. Classification, transitivity
4. Conservation: Number, volume-interior, occupied	4. Peabody
5. Class inclusion	5. Conservation: Number, volume-interior, occupied
6. Conservation: Length, volume-displacement	6. Class inclusion
7. Peabody	7. Raven
8. Matrix	8. Conservation: Length, volume-displacement
9. Raven	9. Matrix

scoring based only on responses to initial questions--yes/no questions, simple judgments, the initial formation of groups in the sorting task, and the initial pattern produced on the cross-classification and cross-seriation tasks, and (b) secondary responses, scoring based on responses given to follow-up questions asking for explanations and justifications of the initial answers. This allowed for quantitative comparisons based only on primary responses, qualitative comparisons based on secondary responses, and a combination of the two for a more complex measure of general competence.

Yes/no questions were scored 1 for a correct answer and 0 for an incorrect answer. Sums were computed for each task. Criteria for justification responses were established by a team of three scorers who also scored each justification response. A reliability check was made using a fourth scorer who was given the criteria and then independently scored every task. Coding reliabilities in terms of percent of agreement ranged from .89 to .92.

Justifications for conservation tasks were considered adequate if they could be classified as belonging to one of the following six categories:

	Description
Inversion:	Child verbalizes and/or demonstrates that the two stimuli are the same if the transformed object(s) are returned to original form.
Reciprocity:	Child verbalizes and/or demonstrates that the two stimuli are the same if the untransformed (standard) object(s) is (are) changed to match the other.

Reciprocity/ Inversion:	Child gives a verbal or nonverbal response which could be either reciprocity or inversion; tester's transcript leaves it ambiguous.
Compensatory Relations:	Child verbalizes that a decrease in one dimension of the transformed stimulus can be compensated by an increase in the other dimension or vice versa so that it remains equal to the standard stimulus.
Addition/ Subtraction:	Child verbalizes and/or demonstrates that: 1. since nothing has been added to or subtracted from either stimulus, they remain equal on the relevant dimension or 2. if some amount was added to or subtracted from one of the stimuli, the two would be the same on the relevant dimension or 3. S counts the number of items in each row (group) and indicates a comparison--or S may simply show a 1-1 correspondence.
Statement of Operations:	Child verbalizes that the shape of the stimulus has been changed but that the transformed stimulus is still the same on the relevant dimension.

Scoring for conservation tasks was done with and without justifications. In the latter case, scores for yes/no answers were summed for each task. In the former case a combined score was obtained (the "transformed score") using the following procedure: For each task component subjects were given a score of 2 if they answered all questions correctly and gave at least one adequate justification. A score of 1 was given if subjects answered two of the three questions correctly and gave at least one adequate justification. Otherwise, scores of 0 were given.

Although justifications were recorded for the classification tasks (dichotomous sorting and class inclusion) no analyses in this report

made use of these justifications. Their description will be omitted here.

Delayed Posttest Procedures

Subjects

Due to attrition too few children remained in the Piagetian Program at the time of the delayed posttests to make such an assessment feasible. From the original Ausubelian group 9 children remained, and 12 children from the control group (the Learning through Play Program). Before conducting the delayed posttesting it was estimated that the children in these two programs did not differ significantly in their posttest performance from those children who had left the program.

Procedure

The test materials, procedures for administration of tasks, and scoring were the same as for the posttests, with the exception of the Peabody and Ravens Tests (see Table 4).

Interim Evaluation

A mid-year evaluation of children's performance in the two contrast groups was conducted to measure the relatively short-term effects of these two experimental programs.

Subjects

Due to constraints on time for completing the interim testing, 12 children were selected from both the Piagetian and Ausubelian programs. The head teacher of each program was asked to select, according to formative assessment data on each child, four children each in the categories advanced, average, slow in development. According to the two head teachers there were only small differences in observed per-

Table 4

Orders of Presentation for Delayed Posttests

A	B
1. Classification, transitivity	1. Relations
2. Conservation: Area weight	2. Conservation: Area, weight
3. Relations	3. Classification, transitivity
4. Conservation:	4. Conservation:
Number	Number
Volume (interior)	Volume (interior)
Volume (occupied)	Volume (occupied)
5. Class inclusion	5. Class inclusion
6. Conservation:	6. Conservation:
Length	Length
Volume (displacement)	Volume (displacement)
7. Matrix	7. Matrix

formance on a range of classroom activities which distinguished the three groupings. Neither group of 12 children was significantly different from the respective overall groups by age, verbal reasoning score, or total group mean scores on the pretest battery. Nor were they significantly different from each other according to these two criteria. It is possible, therefore, to generalize the results from these 24 children to the total sample of 36 children in both programs.

Procedure and Test Materials

Test Materials and Testing Procedures

The test battery consisted of eight classification and three conservation tasks. In the array of classification tasks (spontaneous classification, dichotomous sorting, all and some, and class-inclusion) each had two sections. One version of the task used content from the Ausubelian curriculum such as picture-card representations of species of animals (mammals, birds, fish: part of "living things"), while the second version of each task had content familiar to the children in the Piagetian program. For example, plates, cups, and beakers were selected since children in the Piagetian program were encouraged to classify such objects used at snack time. The first conservation of continuous area task used ladybugs (as a species of animal Ausubelian group children were familiar with) and the second of this type of task, plates arranged on a tabletop area (as material Piagetian children were familiar with and which was sometimes used in "game"-like situations during snack time). Task protocols can be found in Appendix B.

Both parts of each classification task were administered as a "game" to each child individually by two trained testers. Each task took about 15-20 minutes to complete.

For the spontaneous classification task the child was asked to place both a group of animals and a group of "things we use when having snack" into subgroups: e.g., "I would like you to make a number of groups from this large group of animals (or, things we use at snack time)." The animals could be grouped as mammals, fish, and birds; the things used at snack time into cups, glasses, and plates. For dichotomous sorting there was a group of dogs (brown, black, sitting, standing, small, big) which could be sorted into three combinations of two groups and a group of geometrical shapes (squares, circles, red, blue, small, big) which could also be dichotomously sorted three different ways.

For the dichotomous sorting tasks the child was asked to, "Put these shapes/dogs into two groups. Use all the shapes/dogs to make two groups. You must have a special reason for placing the shapes/dogs in each group." For the first subtask the shapes were geometric: circles/squares; big/small; and red/yellow. For the second subtask the dogs were: black/brown; sitting/standing; red tongues out/no tongues out. Thus, in each case, three dichotomous sorts were possible. Each correct sort was scored 1 point, making it possible to score a maximum of 6 points for this task.

In the task measuring the use of "some and all" children were asked, for example, "Here we have a group of mammals, a group of fish, and a group of birds. If the birds flew away, would there be any animals

left?" The answer, of course, is "Yes, the mammals and fish"; that is, some of the animals. Three questions were asked about each set of materials. Each correct response was scored 1 point, providing a possible maximum score of 6 points for this task.

On the class inclusion task the question could be asked, "Are there more animals or more fish?" The child might respond, "More animals." E (examiner) then asked, "When you say there are more animals than fish, which are the animals and which are the fish?" The child should then either say, for example, "The animals are the mammals, birds, and fish, and the fish are just the group of fish," or point to both the superordinate and subordinate class (at which time the class labels could also be stated). Simply to respond, "More animals" without such an explanation received no score. Each correct response with explanation received a score of 1 point. Maximum possible score for this task was 6 points.

The conservation tasks were designed to measure continuous and discontinuous area. It was considered, on the basis of previous research, that conservation of area was rather more difficult than that of length and number but easier than that of volume. In the case of each conservation task only conservation of equivalence was measured.

The first conservation of continuous area (CCA) task had two green, equal area rectangles representing grass, and eight cutout ladybugs. The child is shown that both grass areas are the same size. On one grass area four ladybugs are placed next to each other along one side (A) and on the corresponding grass area, four ladybugs are placed randomly (B). The child is asked, "Can you see as much grass here (A) as you can here (B); can

you see more, or less grass?" The second CCA area had two cardboard rectangles suitably covered with printed paper to represent tabletops and eight miniature plates. The organization of the task was the same as for the first CCA task. The question asked was also the same, substituting tabletop for grass. Finally, the conservation of discontinuous area task (CDA) also used areas of grass. Two cardboard rectangles were each cut into six equal rectanglar pieces. A toy man with his mowing machine was "going to cut the yard." The child was first shown the two complete rectangular yards. One was placed over the other and it was agreed they were the same size (area). They were then placed next to each other and the child was asked, "When the man mows these two yards will he mow the same amount of grass here (A) as here (B), more, or less?" It was made quite clear by E, whenever necessary, that since both yards were the same size, the man would need to mow the same amount of grass. One of the grass yards (B) was then composed into an L-shape. The same comparison was then made between rectangular yard (A) and L-shaped yard (B) as in the first case.

Each correct response was scored 2 and an incorrect response, 0. A maximum possible score for all conservation tasks was 6 points.

Teaching Procedures and Curriculum Materials

With respect to the selection and organization of curriculum materials and teaching methodology a full description of these procedures has been reported in detail elsewhere (see Ershler et al., 1977, and Lawton et al., 1976). Examples of activities used in the Piagetian and Ausubelian programs are provided in Appendix B.

V

RESULTS

Initial Considerations

Initial considerations involve two areas: internal consistency reliability analyses for certain tasks and evaluation of order of presentation effects for the pretest assessments (N = 55). Hoyt estimates of reliability and associated standard errors of measurement were computed for the pretest class inclusion and equivalence conservation (without justification scoring criterion) tasks. The observed values were as follows: class inclusion .66 (SE = 1.12), number conservation .35 (SE = 1.03), length conservation .36 (SE = 1.03), surface area conservation .42 (SE = 1.02), weight conservation .26 (SE = 1.06), internal volume conservation .02 (SE = 1.11), occupied volume conservation .02 (SE = 1.11), and compensatory-displacement volume conservation .39 (SE = .94). It is obvious from an inspection of the pretest means and standard deviations (see Tables 5 to 10) that these reliability values are markedly attenuated by "floor" effects; and this is particularly true for the internal and occupied volume conservation tasks. This is given further support by comparing the present reliability values with an earlier investigation which used identical some-all understanding, class inclusion, length transitivity, length conservation, number conservation, and weight conservation tasks with a sample of kindergarten and third-grade subjects (Hooper, Swinton, & Sipple, 1976). In this instance, the comparison values were as follows: some-all .37 (SE = .45), class

inclusion .67 (SE = .75), length transitivity .94 (SE = 1.06), number conservation .87 (SE = .72), and weight conservation .93 (SE = 1.09). These values would certainly indicate a generally satisfactory level of internal consistency reliability.

The pretest assessment comparison of the two presentation orders (see page 41) indicated only two significant differences, i.e., order one superiority for surface area conservation without supporting justification (means of .296 versus .00) and interior volume conservation without supporting justification (means of 1.56 versus 1.11). Thus the subject scores for the two orders of presentation were combined in all subsequent analyses.

Primary Results

Pretest analyses. A comparison of the mean chronological ages of the three preschool samples (Piagetian, $\bar{X}$ = 51.40 months; Ausubelian, $\bar{X}$ = 49.70 months; and Traditional, $\bar{X}$ = 48.95 months) failed to reveal any significant differences, F (2, 54) = .82, $p < .20$. The pretest and posttest means and standard deviations for the three preschool conditions are presented in Tables 5 to 10. Pretest score distinctions on the major dependent measures were evaluated in an analysis of variance design with specific fixed contrast comparisons. In addition to the sex factor, the major contrasts were the combined Piagetian and Ausubelian conditions versus the control (traditional preschool) condition (Contrast I), and the Piagetian condition versus the Ausubelian condition scores (Contrast II).

Significant pretest score distinctions were found for only three cases: serial correspondence, and the weight and length conservation

Table 5

Pretest and Posttest Means and Standard Deviations for the Peabody Picture Vocabulary Test, Raven Coloured Progressive Matrices, Double Seriation Matrix, Cross Classification Matrix, Dichotomies (Without and With Justification), and Some-All Tasks (Standard Deviations in Parentheses)

Experimental group	PPVT		RCPM		DSM		CCM		Dichotomies without justification		Dichotomies with justification		SA	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Ausubelian														
Males	54.71	54.00	9.71	15.43	.29	1.43	.71	.86	1.14	2.00	1.00	1.71	3.29	3.43
	(6.82)	(13.38)	(2.75)	(2.94)	(.76)	(1.90)	(1.11)	(1.22)	(.90)	(.82)	(.82)	(1.11)	(.76)	(.79)
Females	55.45	58.55	12.09	14.18	.36	1.55	.91	1.18	1.09	2.09	1.00	2.09	3.09	3.64
	(4.66)	(5.79)	(3.18)	(4.14)	(1.21)	(1.86)	(1.38)	(1.47)	(.70)	(.94)	(.77)	(.94)	(1.22)	(.67)
Total	55.17	56.78	11.17	14.67	.33	1.50	.83	1.06	1.11	2.06	1.00	1.94	3.17	3.56
	(5.42)	(9.38)	(3.17)	(3.68)	(1.03)	(1.82)	(1.25)	(1.35)	(.76)	(.87)	(.77)	(1.00)	(1.04)	(.70)
Piagetian														
Males	59.10	61.10	15.00	16.80	.20	.90	.00	.90	1.40	2.50	1.20	2.50	3.50	3.60
	(9.35)	(5.53)	(4.30)	(3.99)	(.42)	(1.66)	(.00)	(1.45)	(.84)	(.85)	(1.03)	(.85)	(.71)	(.52)
Females	54.29	58.14	12.57	15.71	.00	.57	.57	.86	1.00	2.00	.86	2.00	3.14	3.57
	(8.26)	(9.25)	(3.31)	(4.65)	(.00)	(.79)	(1.13)	(1.22)	(.00)	(.82)	(.38)	(.82)	(.69)	(.79)
Total	57.12	59.88	14.00	16.35	.12	.76	.24	.88	1.24	2.29	1.06	2.29	3.35	3.59
	(8.99)	(7.18)	(4.00)	(4.17)	(.33)	(1.35)	(.75)	(1.32)	(.66)	(.85)	(.83)	(.85)	(.70)	(.62)

(continued)

Table 5

(continued)

Experimental group	PPVT		RCPM		DSM		CCM		Dichotomies without justification		Dichotomies with justification		SA	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Traditional														
Males	52.80	56.80	11.40	12.40	.20	.30	.60	.00	1.10	1.60	.90	1.60	3.40	3.40
	(5.67)	(7.27)	(3.53)	(3.69)	(.42)	(.95)	(1.08)	(.00)	(.57)	(.84)	(.57)	(.84)	(.84)	(.84)
Females	51.50	55.30	15.00	15.50	.30	.70	.70	.40	1.10	1.40	1.00	1.30	3.60	3.70
	(6.59)	(6.33)	(3.50)	(3.69)	(.95)	(1.06)	(1.34)	(.84)	(.74)	(.84)	(.82)	(.82)	(.70)	(.48)
Total	52.15	56.05	13.20	13.95	.25	.50	.65	.20	1.10	1.50	.95	1.45	3.50	3.55
	(6.02)	(6.68)	(3.89)	(3.93)	(.72)	(1.00)	(1.18)	(.62)	(.68)	(.83)	(.69)	(.83)	(.76)	(.69)

Table 6

Pretest and Posttest Means and Standard Deviations for the Transitivity and Seriation Tasks

(Standard Deviations in Parentheses)

Experimental group	Transitivity of length		Serial ordering		Serial addition		Serial correspondence		Total seriation	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Ausubelian										
Males	3.86	4.71	5.00	6.43	.43	2.71	12.43	16.71	17.86	25.86
	(1.68)	(.49)	(1.73)	(1.51)	(.53)	(.76)	(3.05)	(1.38)	(4.14)	(2.80)
Females	3.73	4.91	5.00	6.27	.73	2.09	12.27	16.09	18.00	24.45
	(1.27)	(.30)	(1.48)	(1.27)	(.79)	(1.22)	(3.72)	(1.81)	(5.18)	(3.73)
Total	3.78	4.83	5.00	6.33	.61	2.33	12.33	16.33	17.94	25.00
	(1.40)	(.38)	(1.53)	(1.33)	(.70)	(1.08)	(3.38)	(1.65)	(4.67)	(3.38)
Piagetian										
Males	3.90	4.00	5.80	6.60	1.20	2.70	14.00	15.50	21.00	24.80
	(1.66)	(1.89)	(1.87)	(.97)	(1.14)	(.48)	(2.91)	(2.55)	(5.25)	(3.01)
Females	3.43	4.71	3.86	6.29	.86	1.86	11.43	15.00	16.14	23.14
	(1.72)	(.49)	(1.46)	(1.25)	(1.07)	(1.22)	(1.90)	(3.11)	(3.34)	(5.11)
Total	3.71	4.29	5.00	6.47	1.06	2.35	12.94	15.29	19.00	24.12
	(1.65)	(1.49)	(1.94)	(1.07)	(1.09)	(.93)	(2.79)	(2.71)	(5.07)	(3.95)

(continued)

Table 6

(continued)

Experimental group	Transitivity of length		Serial ordering		Serial addition		Serial correspondence		Total seriation	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Traditional										
Males	3.80	4.19	3.80	5.20	.40	1.70	8.90	13.10	13.10	20.00
	(1.32)	(1.41)	(1.32)	(1.87)	(.84)	(1.25)	(3.81)	(3.35)	(4.20)	(5.35)
Females	3.80	3.70	4.70	5.60	1.10	1.50	12.40	15.20	18.20	22.30
	(2.04)	(2.16)	(1.83)	(1.51)	(.99)	(1.58)	(2.21)	(3.05)	(3.97)	(4.90)
Total	3.80	3.85	4.25	5.40	.75	1.60	10.65	14.15	15.65	21.15
	(1.67)	(1.79)	(1.62)	(1.67)	(.97)	(1.39)	(3.53)	(3.30)	(4.76)	(5.13)

Table 7

Pretest and Posttest Means and Standard Deviations for the Various Class Inclusion Tasks With Justifications (Standard Deviations in Parentheses)

	A		B		A and B	
Experimental group	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Ausubelian						
Males	.43	.43	.71	.43	1.14	.86
	(.53)	(.53)	(.49)	(.53)	(.90)	(.90)
Females	.36	.82	.36	.64	.73	1.45
	(.50)	(.40)	(.50)	(.50)	(.90)	(.82)
Total	.39	.67	.50	.56	.89	1.22
	(.50)	(.49)	(.51)	(.51)	(.90)	(.88)
Piagetian						
Males	.10	.50	.10	.40	.20	.90
	(.32)	(.53)	(.32)	(.52)	(.63)	(.99)
Females	.29	.43	.14	.29	.43	.71
	(.49)	(.53)	(.38)	(.49)	(.79)	(.76)
Total	.18	.47	.12	.35	.29	.82
	(.39)	(.51)	(.33)	(.49)	(.69)	(.88)
Traditional						
Males	.10	.50	.00	.30	.10	.80
	(.32)	(.53)	(.00)	(.48)	(.32)	(.92)
Females	.10	.60	.20	.30	.30	.90
	(.44)	(.52)	(.42)	(.48)	(.67)	(.88)
Total	.10	.55	.10	.30	.20	.85
	(.31)	(.51)	(.31)	(.47)	(.52)	(.88)

Table 8

Pretest and Posttest Means and Standard Deviations for the Various Class Inclusion Tasks Without Justifications

(Standard Deviations in Parentheses)

	A		B		A and B	
Experimental group	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Ausubelian						
Males	2.29	2.86	3.43	3.00	5.71	5.86
	(1.89)	(1.22)	(.98)	(1.00)	(2.63)	(1.95)
Females	2.91	3.46	2.64	3.36	5.55	6.82
	(.94)	(1.21)	(1.12)	(.92)	(1.92)	(1.99)
Total	2.67	3.22	2.94	3.22	5.61	6.44
	(1.37)	(1.22)	(1.11)	(.94)	(2.15)	(1.98)
Piagetian						
Males	2.40	3.00	1.90	2.80	4.30	5.80
	(.97)	(1.25)	(1.20)	(1.14)	(1.42)	(2.15)
Females	1.86	3.14	1.71	3.00	3.57	6.14
	(1.77)	(1.22)	(1.25)	(.82)	(2.30)	(1.57)
Total	2.18	3.06	1.82	2.88	4.00	5.94
	(1.33)	(1.20)	(1.19)	(.99)	(1.80)	(1.89)
Traditional						
Males	2.30	3.00	1.50	2.30	3.80	5.30
	(1.06)	(1.16)	(1.08)	(1.25)	(1.87)	(2.16)
Females	2.30	2.80	2.40	2.70	4.70	5.50
	(1.06)	(1.69)	(1.08)	(1.06)	(1.89)	(2.51)
Total	2.30	2.90	1.91	2.50	4.25	5.40
	(1.03)	(1.41)	(1.15)	(1.15)	(1.89)	(2.28)

Table 9

Pretest and Posttest Means and Standard Deviations for the Various Conservation Tasks With Justifications

(Standard Deviations in Parentheses)

Experimental group	Number		Length		Weight		Area		Interior volume		Occupied volume		Displaced volume	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Ausubelian														
Males	.71	2.29	.43	2.00	.57	1.43	.43	1.29	.29	1.00	.29	.00	.00	.00
	(.95)	(2.14)	(.79)	(1.91)	(.79)	(1.81)	(.79)	(1.70)	(.76)	(1.00)	(.76)	(.00)	(.00)	(.00)
Females	.36	2.64	.45	2.36	.00	2.18	.18	1.55	.36	.64	.45	.36	.09	.27
	(.81)	(1.91)	(1.04)	(1.75)	(.00)	(2.09)	(.60)	(1.57)	(1.21)	(.92)	(.82)	(1.21)	(.30)	(.90)
Total	.50	2.50	.44	2.22	.22	1.89	.28	1.44	.33	.78	.39	.22	.06	.17
	(.86)	(1.95)	(.92)	(1.77)	(.55)	(1.97)	(.67)	(1.58)	(1.03)	(.94)	(.78)	(.94)	(.24)	(.71)
Piagetian														
Males	.20	.90	.40	.20	.20	.50	.30	1.60	.00	.40	.10	.20	.20	.00
	(.63)	(.99)	(.70)	(.63)	(.42)	(.71)	(.67)	(1.84)	(.00)	(1.26)	(.32)	(.63)	(.63)	(.00)
Females	.00	1.00	.00	.57	.29	.14	.57	.57	.00	.57	.00	.00	.00	.00
	(.00)	(1.15)	(.00)	(.98)	(.76)	(.38)	(1.51)	(1.51)	(.00)	(.79)	(.00)	(.00)	(.00)	(.00)
Total	.12	.94	.24	.35	.24	.35	.41	1.18	.00	.47	.06	.12	.12	.00
	(.49)	(1.03)	(.56)	(.79)	(.56)	(.61)	(1.06)	(1.74)	(.00)	(1.07)	(.24)	(.49)	(.49)	(.00)

(continued)

Table 9

(continued)

Experimental group	Number		Length		Weight		Area		Interior volume		Occupied volume		Displaced volume	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Traditional														
Males	.60	.80	.50	1.20	.00	.20	.60	1.20	.30	.50	.00	.20	.00	.80
	(1.26)	(1.32)	(.85)	(1.40)	(.00)	(.63)	(1.35)	(1.69)	(.67)	(1.27)	(.00)	(.63)	(.00)	(1.32)
Females	.30	.70	.90	1.20	.00	.10	.60	.50	.00	.10	.10	.00	.20	.00
	(.67)	(1.34)	(1.20)	(1.75)	(.00)	(.32)	(.97)	(1.08)	(.00)	(.32)	(.32)	(.00)	(.42)	(.00)
Total	.45	.75	.70	1.20	.00	.15	.60	.85	.15	.30	.05	.10	.10	.40
	(1.00)	(1.29)	(1.03)	(1.54)	(.00)	(.49)	(1.14)	(1.42)	(.49)	(.92)	(.50)	(.45)	(.31)	(.99)

Table 10

Pretest and Posttest Means and Standard Deviations for the Various Conservation Tasks Without Justifications

(Standard Deviations in Parentheses)

Experimental group	Number		Length		Weight		Area		Interior volume		Occupied volume		Displaced volume	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Ausubelian														
Males	2.86	4.71	3.86	4.14	3.57	4.29	3.29	4.29	3.43	4.14	2.43	2.43	2.57	4.29
	(1.77)	(2.22)	(1.57)	(1.77)	(1.13)	(1.80)	(1.38)	(1.70)	(1.51)	(1.95)	(1.40)	(2.15)	(1.40)	(2.14)
Females	3.27	5.00	3.36	4.91	2.46	4.73	2.82	3.73	3.09	3.64	3.64	3.18	2.64	4.36
	(1.35)	(1.48)	(1.29)	(1.51)	(1.57)	(1.68)	(1.72)	(1.56)	(1.30)	(2.01)	(1.36)	(1.54)	(.92)	(1.69)
Total	3.11	4.89	3.56	4.61	2.89	4.56	3.00	3.94	3.22	3.83	3.17	3.67	2.61	4.33
	(1.49)	(1.75)	(1.38)	(1.61)	(1.49)	(1.69)	(1.57)	(1.59)	(1.35)	(1.95)	(1.47)	(1.85)	(1.09)	(1.82)
Piagetian														
Males	3.10	4.10	3.50	3.90	2.30	3.30	3.40	4.10	2.60	3.30	2.70	2.80	3.20	3.70
	(1.73)	(1.45)	(1.35)	(1.85)	(.95)	(1.42)	(.97)	(1.66)	(1.08)	(1.64)	(.48)	(1.81)	(1.55)	(1.06)
Females	2.43	3.86	2.29	3.86	3.43	3.00	2.86	3.14	3.00	3.00	2.43	3.14	2.29	3.57
	(.98)	(1.22)	(.49)	(1.07)	(1.40)	(1.63)	(1.46)	(1.35)	(1.00)	(1.16)	(1.51)	(.90)	(1.80)	(1.62)
Total	2.82	4.00	3.00	3.88	2.77	3.18	3.18	3.71	2.77	3.18	2.59	2.94	2.82	3.65
	(1.47)	(1.32)	(1.22)	(1.54)	(1.25)	(1.47)	(1.19)	(1.57)	(1.03)	(1.43)	(1.00)	(1.48)	(1.67)	(1.27)

(continued)

Table 10

(continued)

Experimental group	Number		Length		Weight		Area		Interior volume		Occupied volume		Displaced volume	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Traditional														
Males	2.50	3.40	2.80	3.80	1.60	2.60	2.70	3.70	2.50	2.00	2.60	2.80	3.00	3.70
	(1.43)	(1.90)	(1.69)	(2.15)	(1.17)	(1.90)	(1.42)	(1.70)	(1.58)	(1.49)	(1.17)	(1.48)	(1.41)	(1.49)
Females	3.00	3.20	3.60	3.70	2.30	2.80	2.40	2.80	2.30	2.90	2.50	2.80	2.00	4.40
	(1.15)	(1.40)	(1.51)	(1.95)	(1.16)	(1.93)	(1.84)	(1.48)	(.67)	(1.29)	(1.18)	(1.69)	(.82)	(1.35)
Total	2.75	3.30	3.20	3.75	1.95	2.70	2.55	3.25	2.40	2.45	2.55	2.80	2.50	4.05
	(1.29)	(1.63)	(1.61)	(2.00)	(1.19)	(1.87)	(1.61)	(1.62)	(1.19)	(1.43)	(1.15)	(1.54)	(1.24)	(1.43)

scores. The combined experimental condition versus control contrast was significant for the serial correspondence task, F (1, 49) = 5.23, p < .03, which reflected the combined experimental group superiority (see Table 6); and this was particularly notable for the Piagetian group male children, contrast I/sex interaction F (1, 49) = 7.71, p < .01. The weight conservation task distinctions included the following significant contrasts: Contrast I, F (1, 49) = 6.27, p < .02, favoring the experimental children for the without justification scoring criterion; and for the more stringent justification scoring criterion, F (1, 49) = 3.73, p < .06 (See Tables 9 and 10); a significant Contrast II x sex interaction for the without justification scores, F (1, 49) = 6.75, p < .01, and a similar result for the with justification scores, F (1, 49) = 5.08, p < .03 which reflected the differential superiority of the experimental male children in the Ausubelian group and the female children in the Piagetian group. In the length conservation without explanation case, the Contrast I x sex interaction was significant, F (1, 49) = 4.37, p < .04, which reflected the lower pretest scores for the Piagetian condition female children and traditional group male children (see Table 10).

Posttest analyses. Identical analyses of variance with controlled contrasts were conducted with the posttest data. Significant comparisons included the following class, relations, and conservation cases. Contrast I (experimental versus control children) was significant for the dichotomies without justification scoring criterion, F (1, 49) = 7.77, p < .01; dichotomies with associated justification, F (1, 49) = 7.00, p < .01; and for the multiple classification task, F (1, 49) = 5.74, p < .02. All of the compari-

sons favored the combined experimental group children. None of the Contrast II, sex, or contrast x sex interactions were significant for any of the classification concept tasks.

In the relations concept domain, significant comparisons favoring the experimental children were found for Contrast I in serial ordering, F (1, 49) = 6.25, $p < .02$, in additive seriation, F (1, 49) = 5.22, $p < .03$, and in the serial correspondence case, F (1, 49) = 5.09, $p < .03$. No other contrasts or interactions approached significance.

For the conservation tasks, slightly different patterns were found for the two scoring criteria. For the without justification scoring case, three Contrast I comparisons were significant, i.e., number, F (1, 49) = 6.46, $p < .01$, weight, F (1, 49) = 5.94, $p < .02$, and interior volume, F (1, 49) = 5.42, $p < .02$. In all instances, the experimental children outperformed their control counterparts (see Table 10). In addition, the Contrast II comparison for weight, F (1, 49) = 5.52, $p < .02$, reflected the differential superiority of the Ausubelian children on posttest. None of the sex or contrast x sex interactions were significant. In the with justification scoring case (see Table 9), similar Contrast I results were found for number, F (1, 49) = 5.46, $p < .02$, and for weight conservation F (1, 49) = 8.40, $p < .001$. There were three significant Contrast II cases, all favoring the Ausubelian children, i.e., number, F (1, 49) = 9.25, $p < .004$, length, F (1, 49) = 13.98, $p < .001$, and weight conservation, F (1, 49) = 13.81, $p < .001$.

Controlled comparisons with time of measurement as a factor. The changes over time (pretest versus posttest scores) were also

evaluated in an analysis of variance design. This mixed model case had two between-subject factors (experimental condition and sex) and one within-subject variable (time of assessment). The same fixed contrasts as reported above were employed. The time of measurement factor, in which overall posttest scores exceeded those shown on pretesting, was significant for all measures except multiple classification, internal volume conservation in the without justification scoring condition, and occupied volume conservation in both scoring conditions (analyses of the transitive inference and some-and-all understanding tasks were not conducted since pretest "ceiling" effects were apparent). For the RCPM test the significant Contrast I x time interaction, F (1, 49) = 5.02, $p < .03$, reflected the relatively greater differential superiority of the combined experimental children at posttesting compared to the control children (see Table 5) and these differences were primarily due to the Ausubelian male children (pretest/posttest mean differences of 5.72) and Piagetian female children (mean difference of 3.14), Contrast I x sex interaction, F (1, 49) = 4.53, $p < .04$. The Contrast II main effect was also significant, F (1, 49) = 4.20, $p < .05$, and the experimental preschool differences which favored the Piagetian group overall showed differential patterns for males and females, i.e., Contrast II x sex x time interaction, F (1, 49) = 4.24, $p < .05$.

A number of significant main effects and interactions were found for the various classificatory ability measures. In the case of the dichotomies task the Contrast I main effect was significant for the objective response scoring condition, F (1, 49) = 4.413, $p < .04$, and for the associated justification scoring criterion, F (1, 49) = 4.01, $p < .05$. In each instance the experimental children outscored their control counterparts

and these distinctions were most notable on posttesting, i.e., Contrast I x time interaction F values of 5.30 and 4.16, $p < .05$, respectively. Analysis of class inclusion B (abstract shapes) revealed a significant Ausubelian group superiority, i.e., Contrast II, F (1, 49) = 6.19, $p < .02$. The same relative superiority was shown on the total class inclusion score, however, the Contrast II F value of 3.24 only approached significance, $p < .08$. A separate series of t-test comparisons were conducted to evaluate any differences between class inclusion A (people) and class inclusion B (abstract shapes). All of these contrasts (for both the with justification and without justification scoring criteria) were uniformly nonsignificant (see Tables 7 and 8). This was true for all the treatment conditions.

In the analysis of the seriation task total scores the Contrast I F value of 7.92, $p < .01$, indicated the combined experimental group superiority (see Table 6) and these differences were most notable for the male children, i.e., Contrast I x sex interaction, F (1, 49) = 6.34, $p < .02$. In addition, the double seriation matrix task pretest/posttest changes were somewhat greater in the Ausubelian group, i.e., Contrast II, F (1, 49) = 3.09, $p < .09$, (see Table 5).

The patterns of significant differences for the conservation tasks varied somewhat depending upon which scoring criterion was employed (objective response alone or objective response with associated justification). For example, the Contrast I comparison for number conservation, F (1, 49) = 4.15, $p < .05$, was significant reflecting the combined experimental group superiority but this contrast failed to reach significance in the with justification scoring condition. In the latter scoring condi-

tion, however, the Contrast I x time interaction, F (1, 49) = 7.943, $p < .007$, revealed the marked superiority of the experimental children's performances at time of posttesting. These distinctions were primarily due to the marked pretest/posttest changes for the Ausubelian-trained children, i.e., Contrast II, F (1, 49) = 8.351, $p < .01$, and Contrast II x time interaction, F (1, 49) = 5.93, $p < .02$, (see Table 9). In the case of length conservation without justification, the Contrast I x sex x time interaction, F (1, 49) = 4.71, $p < .04$, was the only value which was significant. For the with justification scoring criterion both the Contrast I, F (1, 49) = 10.37, $p < .002$, and Contrast I x time interaction, F (1, 49) = 10.53, $p < .002$, values were significant. These comparisons reflect the differential superiority of the experimental children on posttesting although it is somewhat surprising that the Contrast II values failed to reach significance in view of the rather striking Ausubelian group mean scores compared to those of the Piagetian children as shown in Table 10.

Analysis of surface area conservation with justification scores indicated no significant main effects for either Contrast I or Contrast II, but the Contrast I x time interaction, F (1, 49) = 3.74, $p < .06$, reflected the general experimental group superiority at time of posttesting. This was particularly true of the Piagetian male children who performed very similarly to the males and the females in the Ausubelian group, i.e., Contrast II x sex x time interaction, F (1, 49) = 3.87, $p < .05$, (see Table 9).

The volume conservation tasks also presented a somewhat mixed picture and the only significant contrasts concerned the without justification

scoring criterion (an analysis of the compensatory-displacement volume conservation task with supporting explanation criterion was not possible due to the rather obvious "floor" effects at time of pretesting, see Table 10). Contrast I main effects resulting from the anticipated experimental group instructional programs were significant for internal volume, F (1, 49) = 6.67, $p < .01$, but not for the occupied volume task. In the case of the latter task the Contrast II main effect, F (1, 49) = 4.69, $p < .035$, and the Contrast II x sex x time interaction, F (1, 49) = 3.89, $p < .05$, resulted from the differential score increases for Ausubelian males and Piagetian females compared to their opposite sex peers (see Table 10). Overall, the Ausubelian and control group occupied volume mean scores are quite similar while each condition is higher than the Piagetian experimental group.

Finally, two additional comparisons of inter-item task difficulty were conducted. In accord with previous investigations of logical matrix abilities (e.g., Hooper, Sipple, Goldman, & Swinton, in press; MacKay et al., 1970; Shantz, 1967; Sipple & Hooper, 1976) the relative difficulties of multiple classification and multiple seriation were compared. No significant differences were found for any of the treatment conditions. These results are not surprising in view of the age range of the present children (Sipple & Hooper, 1976) and the overall difficulty of these task formats. There were, however, indications of significant development/learning for the present experimental children. Thus for multiple classification scores there was a significant pretest/posttest increase for the Piagetian children ($t = 1.69$, $df = 30$, $p < .05$),

while the average multiple seriation scores increased significantly for both the Piagetian and the Ausubelian program participants (t = 1.84, df = 30, $p < .05$, and t = 2.31, df 32, $p < .025$, respectively). No such gains were shown by the control group children.

A similar body of previous research has concerned the relative difficulty of transitive inference and conservation tasks matched as to content domain (see reviews by Brainerd, 1973, Hooper, Toniolo, & Sipple, in press; Hooper, Wanska, Peterson, & DeFrain, in press). Comparisons of the present length transitivity and length conservation tasks were uniformly nonsignificant for the without justification conservation scoring criterion. In direct contrast when the associated conservation justifications are included, all the t-test contrasts for each treatment condition favor the transitive inference task performances (all probabilities < .001). Classical conservation is clearly a more difficult and later appearing concept attainment than transitive inference and this is in general accord with the reviews cited above.

Delayed Posttest Results

An important question related to training studies is that of durability of learning. To examine this question the delayed posttests were readministered after an interim period of almost 6 months. The delayed posttest results are presented in Tables 11 and 12.

The results are described according to tasks which fall within the three main categories of classification, relations, and conservation. Analyses of variance on the delayed posttest data were similar to the procedure adopted for the posttest analyses but no apriori contrasts

were specified. Significant comparisons were as follows. First, in the classification category: class inclusion with justification, $F(1, 19) = 9.3$, $p < .01$; multiple classification, $F(1, 19) = 8.9$, $p < .01$. In the relations category: additive seriation, $F(1, 19) = 7.09$, $p < .01$; and, serial correspondence, $F(1, 19) = 18.82$, $p < .005$. Finally, in the conservation category: conservation of number with justification, $F(1, 19) = 8.29$, $p < .01$; conservation of weight with justification, $F(1, 19) = 6.23$, $p < .05$; conservation of interior volume with justification, $F(1, 19) = 9.8$, $p < .01$; and, conservation of occupied volume, $F(1, 19) = 9.5$, $p < .01$. All of the comparisons favored the Ausubelian group. An examination of Tables 11 and 12 indicates that on all other tasks the data indicated a trend in improvement of learning favoring the Ausubelian group. None of the contrasts by sex were significant. These comparisons indicate that the superior performance of children receiving advance organizer lessons instruction was maintained over a considerable period of time. The results clearly reflect those obtained from the posttest analyses with two additions; significant differences are now found with respect to class inclusion and occupied volume. A comparison of mean scores in Tables 11 and 12 for the Ausubelian and control groups with respect to all tasks indicates a continued improvement of performance on almost all tasks for the Ausubelian group, whereas that for the control group shows little improvement, and in some cases, regression. In general, these findings support the long-term effectiveness of advance organizer instruction.

Table 11

Mean Scores and Standard Deviations for Delayed Posttests: Classes and Relations

(Standard Deviations in Parentheses)

Treatment group	N	Relations					Classes					
		TL	SO	SA	SC	DSM	DS[a]	DS	SA	CI	CI[a]	CCM
A	9	4.7	6.7	2.6	17.1	1.9	2.0	1.8	3.9	6.8	3.5	2.7
		(0.7)	(0.3)	(0.3)	(0.9)	(0.5)	(1.0)	(0.8)	(0.7)	(0.7)	(0.9)	(0.5)
C	12	4.1	6.3	1.6	14.1	0.2	1.6	1.6	3.4	5.5	0.9	0.4
		(0.5)	(0.4)	(0.3)	(0.9)	(0.6)	(1.0)	(0.7)	(0.4)	(0.9)	(0.9)	(0.8)

Note. Relations: Transitivity of length (TL), Serial ordering (SO), Serial addition (SA), Serial correspondence (SC), and Double series matrices (DSM). Classes: Dichotomous sorting (DS), Some/all (SA), Class inclusion (CI), and Cross-class matrices (CCM).

[a]Indicates same version of test with justification.

Table 12

Mean Scores and Standard Deviations for Delayed Posttests: Conservation

(Standard Deviations in Parentheses)

Treatment group	N	Conservation													
		CN	CN[a]	CL	CL[a]	CA	CA[a]	CW	CW[a]	CIV	CIV[a]	COV	COV[a]	CDV	CDV[a]
A	9	4.9	3.0	4.6	2.2	3.4	1.0	4.1	1.3	3.8	0.9	4.3	0.6	5.1	0.3
		(0.6)	(0.5)	(0.6)	(0.6)	(0.5)	(0.5)	(0.6)	(0.5)	(0.7)	(0.5)	(0.5)	(0.4)	(0.6)	(0.3)
C	12	3.7	0.9	4.3	1.0	2.8	0.4	3.4	0.2	2.5	0.0	2.4	0.1	4.1	0.0
		(0.5)	(0.4)	(0.5)	(1.0)	(0.4)	(0.4)	(0.5)	(0.6)	(0.5)	(0.0)	(0.5)	(0.9)	(0.7)	(0.0)

Note. Conservation: Conservation of number (CN), Conservation of length (CL), Conservation of area (CA), Conservation of weight (CW), Conservation of interior volume (CIV), Conservation of occupied volume (COV), and Conservation of displaced volume (CDV).

[a]Indicates same version of test with justification.

Interim Evaluation

Approximately midway through the school year a series of tests were administered primarily aimed at measuring the relatively short-term effects on performance of both the Ausubelian and Piagetian programs. The tasks used (a) spontaneous classification, dichotomous sorting, the use of some/all, and class inclusion, and (b) three conservation of area tasks (to include the measurement of continuous and discontinuous area). Each classification task had two subtasks. One used content from the Ausubelian curriculum, and the other, content from the Piagetian curriculum. This was the case for the two conservation of continuous area tasks. The content for the discontinuous area task was neutral (see Appendix A).

The interim evaluation coincided with a point in time when the children in the Ausubelian Program had completed a section of the curriculum dealing with a certain array of subject matter and process concepts.[1] The children in the Piagetian Program were obviously not following such a schedule, but the general program schedule from the beginning of the year was aimed at the spontaneous development of concrete operations generally. The hypothesis for such a course of intellectual growth is based in part on the Genevan theory of synchronous development of operations at each stage level.

With respect to the interim evaluation three questions were asked: (a) Would it be possible to enhance or accelerate intellectual development in the short run? (b) Would there be near-near, near-far, and far-

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[1] Since the process concepts (concrete operations) are common to both programs, it is worth mentioning here that, at this time, children in the Ausubelian program had been introduced to hierarchical classification, conservation of number, length, and area.

far transfer? (c) Would task content affect performance?

Results and Conclusions

The results can best be summarized in relation to the three questions asked. Means and standard deviations for interim tasks are presented in Table 13. First, it was established that for each treatment group there were no significant differences in performance on the subtasks of each classification task. Further analyses used the average score for each of these tasks. A multivariate ANOVA (treatment groups x task) indicated a significant difference in performance favoring the Ausubelian group: $F(1, 166) = 23.4$, $p < .001$. In answer to question 1, therefore, the Ausubelian program was more effective, overall, in facilitating performance on these tasks. Further analyses showed that the Ausubelian group outperformed the Piagetian group on: some/all, $t(1, 23) = 4.3$, $p < .01$; spontaneous classification, $t(1, 23) = 5.7$, $p < .01$; class inclusion, $t(1, 23) = 2.7$, $p < .02$, but on dichotomous sorting there was no difference between the two groups. The Ausubelian group also outperformed the Piagetian group on all conservation tasks: CCA^a (ladybugs), t (1, 23) = 4.9, $p < .01$; CCA^b (plates), t (1, 23) = 3.7, $p < .01$, and CDA (mowing the yard), $t(1, 23) = 3.9$, $p < .01$.

Question 2 is concerned with transfer between tasks. First, for both groups, on the subtasks of each task (near-near transfer), performance was about the same. The results do indicate that the Piagetian group tended to find tasks using content from their curriculum a little easier to deal with. Second, for the Ausubelian group there was no difference between their performance on each classification task (near-

Table 13

Means and Standard Deviations for Interim Tasks

Treatment group	N	SC	DS	SA	CI	CCA[a]	CCA[b]	CDA
A	12	4.7 (1.2)	4.8 (1.6)	5.7 (1.4)	3.7 (1.9)	1.5 (0.8)	1.3 (0.6)	1.6 (1.2)
P	12	1.8 (1.9)	4.6 (1.7)	2.6 (1.8)	1.4 (2.4)	0.9 (0.6)	0.5 (0.7)	0.2 (0.6)

Note. The maximum score possible is 6 points for each task. Abbreviations used are: Spontaneous classification (SC), Dichotomous sorting (DS), Use of some and all (SA), Class inclusion (CI), Conservation of continuous area (tabletop) (CCA[a]), Conservation of continuous area (grassed yard) (CCA[b]), Conservation of discontinuous area (CDA), Ausubelian group (A), and Piagetian group (P).

far transfer), or the conservation tasks (near-near transfer), when these two groups of tasks were kept separate. For children in the Piagetian program, significant differences in performance did occur between classification tasks, $F(2, 34) = 3.9$, $p < .05$. Low scores made little variance possible for this group on the conservation tasks. There is an indication that CCA was found easier to deal with than CDA. Over all tasks, for both groups, there was a significant difference between task means: Ausubelian group, $F(6, 78) = 2.47$, $p < .05$; Piagetian group, $F(6, 78) = 3.89$, $p < .01$. From an observation of Table 13 it can be seen that, in the first case, this result indicates little or no far-far transfer. The result for the Piagetian group can be attributed to both lack of near-far and far-far transfer.

Finally, question 3 relates to content effects on task performance. Success or failure on the first version of each classification task was repeated on the second version, and results indicated that "spontaneously" used materials in the Piagetian classroom did not appear to make classification tasks less difficult for children in that program. However, while these differences were not statistically significant, it is apparent from the data that the Piagetian group did find content from the Ausubelian program more difficult to deal with.

Summary

Children in the Ausubelian program showed significantly superior progress on the interim tasks compared to those in the Piagetian program. Since transfer effects are in the direction predicted for the Ausubelian group (near-near and near-far, in that order), this data generally supports the efficacy of advance organizer lessons.

Tasks Relationships Analysis

A study of relationships among tasks included the complete set of tasks used in the pretests and posttests. A principal components analysis was completed for posttest data only and was restricted to both experimental groups combined. Pretest data had indicated Ss to be generally naive with respect to concrete operations (see Tables 5 to 10). ANOVAs of posttest results showed that, overall, the two experimental groups tended to outperform the control group while maintaining a certain degree of compatability in performance.

Inspection of the correlation matrix (see Table 14) reveals that tasks generally cluster in a pattern consistent with expectations. Of interest is: (a) the relationship between serial ordering, serial addition, and serial correspondence with conservation of number (r = .53, .56, and .51, respectively) with the relational tasks clustering; (b) the conservation tasks split into two clearly distinct groups--number, length, area, and weight, and the three conservation of volume tasks; (c) multiple seriation relates most positively to the number, length, area, and weight conservation tasks and to serial correspondence. All these tasks require some understanding of number relations in multidimensional tasks; (d) multiple classification correlates with multiple seriation (r = .39), conservation of number (r = .44), and serial correspondence (r = .37). This group of tasks appears to require understanding of both number and matrix relations as they relate to correspondences in multiple classification; (e) the PPVT relates most positively to classification tasks, while the RCMT relates most positively with number tasks--

Table 14

Intercorrelations Among Posttest Tasks for the Combined Ausubelian and Piagetian Sample

Task	TL	SORD	SADD	SCOR	PPVT	RAVEN	D	SA	CIAB3	MC	MS	CNT	CLT	CAT	CWT	CIVT	COVT	CDVT
TL	1.000																	
SORD	.000	1.000																
SADD	.031	.375	1.000															
SCOR	.124	.485	.497	1.000														
PPVT	.142	.173	.377	.127	1.000													
RAVEN	-.093	.431	.388	.421	.394	1.000												
D	.018	.391	.342	.305	.544	.530	1.000											
SA	.106	.2 6	.186	.188	.482	.344	.554	1.000										
CIAB3	.070	.362	.193	.463	.373	.300	.443	.514	1.000									
MC	-.050	.288	.187	.365	.104	.059	.004	.122	.270	1.000								
MS	.101	.348	.276	.351	.214	.376	.066	.059	.282	.386	1.000							
CWT	.099	.534	.563	.512	.316	.322	.414	.334	.449	.440	.494	1.000						
CLT	.217	.222	.367	.266	.299	.282	.397	.305	.318	.283	.358	.691	1.000					
CAT	-.027	.369	.284	.309	.163	.266	.506	.357	.384	.055	.391	.504	.396	1.000				
CWT	-.074	.297	.282	.315	-.018	.113	.114	.191	.410	.168	.428	.623	.539	.587	1.000			
CIVT	-.051	.341	.202	.167	.136	.169	.257	.384	.493	-.032	.403	.372	.282	.788	.670	1.000		
COVT	.234	.125	.195	.092	.119	.099	.104	.311	.342	.096	.207	.348	.295	.477	.439	.599	1.000	
CDVT	.017	.310	.204	.016	.268	.168	.259	.141	.318	-.140	.238	.324	.243	.450	.411	.526	.601	1.000

dichotomous sort (counting into two) (r = .53), multiple seriation (r = .38), and some/all (which could be interpreted as requiring some application of numeracy) (r = .34). Although neither of these tasks share the clustered relationships, they do have a moderate intercorrelation (r = .39).

Varimax rotation of the first four factors all with eigenvalues > 1.00, accounting for 53.0% of the variance, led to the description presented in Table 15. The first factor is clearly defined by the more complex conservation tasks; area, weight, interior volume, occupied volume, and displaced volume. The two conservation tasks of length and number remain separate. Both tasks are probably easier to deal with since they present limited, perceptually clear (unidimensional), concrete properties that must be attended to. The second factor is just as clearly defined by relations tasks, which include, not surprisingly, the related multiple class and relations matrix tasks, and the conservation of number task. The third factor is dominated by the classification tasks, which are accompanied by the PPVT and RCMT. The RCMT appears to have a stronger relationship to classificatory skills than relational skills. The fourth, and final, factor can be attributed solely to transitivity of length and thus reflects a general task difficulty dimension. These results are important in that, given the limitations of a factor analysis with this data, a clear four dimensional structure emerges. This analysis lends some support to the argument which opposes the "structure-of-the-whole" position. Since these results follow a year long training study, it can be tentatively suggested that, whether the emphasis in early education is on formal or informal instruction, teaching should be geared to (a) individual

Table 15

Varimax Rotated Factor Matrix, Principal Components Procedure, for all Posttest Tasks

Task	Varimax factors			
	1	2	3	4
TL	-.019	.050	.085	.815
SORD	.217	.550	.321	-.295
SADD	.100	.541	.370	-.029
SCOR	.017	.728	.255	-.092
PPVT	.019	.093	.768	.238
RAVEN	.034	.343	.636	-.305
D	.169	.126	.850	-.093
SA	.261	.041	.699	.186
CIRS3	.396	.328	.458	.081
MC	-.122	.725	-.080	.140
MS	.311	.640	-.005	.015
CNT	.375	.743	.266	.146
CLT	.324	.512	.256	.378
CAT	.753	.243	.269	-.149
CWT	.733	.460	-.102	-.030
CIVT	.891	.117	.146	-.118
COVT	.747	.049	.070	.348
CDVT	.732	-.044	.208	.011
Factor variance	3.66	3.42	3.02	1.30

emphasis in organizing learning situations in the four areas identified, and (b) sequentially related instructional sequences within each of the four areas, the expectancy being that near-near and near-far transfer has the highest possibility of occurring. The concept of far-far transfer (e.g., classification to relations, etc.) provides us with continuing questions: What factors constitute the restraints and opportunities for such transfer to occur? What is the practical importance, if any, of this type of transfer? If such transfer is unlikely to occur, or can be shown to have little practical value, how does learning and transfer in each of the four skill areas identified best proceed? Will this four dimensional structure become integrated as a function of continuing maturation, experience, learning, and instruction?

Descriptive Analysis of the Conservation Justification Data

A descriptive, or qualitative analysis of the conservation concept data consists of examining judgment responses as well as the explanation data which accompanied those judgments. Brainerd (1973, 1974, 1977) argues that the most accurate measure of the presence of a particular concept in the child's cognitive competence is that measure which requires the least behavioral evidence of its presence. He states that the response criterion requiring a correct judgment-only answer has less error associated with it (less false positive error) than a correct judgment-with-explanation answer, which would have a greater probability of error (false negative error). The limitation of this intuitively simple argument is the fact that the less demanding judgment-only response criterion may not actually measure the functioning of the particular cognitive con-

cept and provides little information about the child's status in the acquisition of that concept (Beilin, 1976; Gruen, 1966; Inhelder, Smock, Bovet, & Sinclair, 1966; Inhelder et al., 1974; Reese & Schack, 1974; Smedslund, 1969). Thus, although Brainerd's intent is to reduce psychometric error so as to make the test more sensitive, his method allows measurement error by eliminating data which support, constrain, or even negate the judgments they accompany. The justifications in the present study do not indicate that the children's judgments are only due to guessing, perceptually misleading cues, and "irrelevant hypotheses" (Smedslund, 1969; Reese & Schack, 1974), but are also due to systematic misinterpretations of the questions posed to them, and to hypotheses very relevant to their status in conservation acquisition, such as exactly on what dimensions or properties children base their comparisons, and how they apply their understanding of these dimensions to the stimulus material at hand. We argue that the child's "yes" or "no" answers are particularly subject to error, and suggest that there are other minimal behavioral responses which might be used. However, one cannot control, or provide stimulus refinements, for error that one is not aware of, and for this reason we offer an examination of the response trends and other information provided by the justification data.

Justification Data Summary

The justification explanation data, as summarized in Table 16, is organized according to the type of explanation given, the frequency with which it was used, and whether it was given with a correct or incorrect judgment. The table includes justification data for four concept domains,

Table 16

Summary of Justification Data

Number of subjects giving adequate (relevant) justifications for incorrect judgments					Number of subjects giving adequate justifications for correct judgments			
Pretest					Pretest			
	inv/rec	oper	add/sub	comp	inv/rec	oper	add/sub	comp
Conservation of number								
Aus. (N=18)	13	0	2	0	1	0	4	0
Piag. (N=17)	11	0	2	0	1	1	1	0
Trad. (N=20)	12	0	2	0	2	1	5	0
Conservation of length								
Aus.	17	1	1	0	5	1	1	0
Piag.	11	1	0	0	4	2	0	0
Trad.	8	1	0	0	7	1	0	0
Conservation of weight								
Aus.	9	0	0	0	2	1	0	0
Piag.	11	0	1	0	2	1	0	0
Trad.	11	0	2	0	0	0	1	0
Conservation of interior volume								
Aus.	12	0	1	0	0	0	2	0
Piag.	13	1	0	0	0	1	1	0
Trad.	13	0	0	0	0	1	1	0
Posttest					Posttest			
Conservation of number								
Aus.	4	0	2	0	0	7	12	0
Piag.	13	0	4	0	4	4	3	0
Trad.	13	1	6	0	6	1	4	0
Conservation of length								
Aus.	8	0	2	0	7	3	9	0
Piag.	13	0	0	0	2	2	0	0
Trad.	11	0	0	0	7	5	0	0
Conservation of weight								
Aus.	7	0	2	0	2	2	8	0
Piag.	15	0	0	0	3	0	2	0
Trad.	17	0	0	0	1	1	1	0
Conservation of interior volume								
Aus.	10	0	2	0	2	0	7	1
Piag.	15	0	1	0	5	0	3	0
Trad.	16	0	2	0	3	0	2	0

number, length, weight, and interior volume. Summary data is not included for the conservation of area task because results showed that the stimulus materials confused the children about which attribute was referred to. Conservation of occupied and displacement volume tasks were excluded here because very few justifications were made. The type of explanation given, and the extent of its adequacy, allows the experimenter to examine the developmental status of the child's functioning concept, how that status changes over time, and for which of the several concept domains. From the justification data, one can assess: (a) whether the judgment is relevant to the question asked; (b) exactly what bases of comparison the child is using to make his judgments and specifically to which stimulus attributes or physical properties he is referring; (c) the types of explanations given to incorrect judgments and how they differ from those given to correct judgments; (d) whether a particular concept prompts a particular type of explanation; (e) whether concept acquisition progresses from using one particular type of explanation to another type, or whether there are levels of adequacy of explanations within a given justification type; and (f) whether any one type of explanation reflects an approach to the problem which is more facilitative than others in furthering the acquisition of that or other concepts.

The Adequacy Criterion

For a child's verbal explanation to be considered an adequate justification it had to be relevant to the task by referring to actual attributes of the task stimuli or their physical properties, and/or to their

transformation in configuration, or their transformation over time (see Appendix A). An adequate justification, even though accompanying an incorrect judgment, for example in the conservation of number task, would have to refer to the discontinuous quantity (pennies), or to their number, or the spaces between them, and/or to their changed configuration or its consequence. A simple statement that they are "the same" is not considered adequate because when the child states simply that something is the "same," the basis for his comparison is unknown. Accordingly, the response "Get them the same" is not considered an adequate inversion/reciprocity justification because it is not clear to what attribute the child refers. The child could mean the attribute of length (even though the question referred to number), one-to-one correspondence, or as in one task protocol, a child was concerned that the pennies were all face up and not upside-down. An adequate response, then, would be this example:

> The child was being presented with two rows of 10 pennies in this configuration:
>
> Row A: • • • • • • • • • •
>
> Row B: • • • • • • • • • •
>
> The particular question asked:
>
> E: Does this row (A) have more pennies?
>
> S: Yes.
>
> E: How did you know that?
>
> S: Because you made it far away from each other; put it back in the row like it was.

In this way the child adequately justifies the present "inequality" as being due to spatial arrangement, and that even though the two rows

are presently unequal in number, they can be made equal again by returning them to their initial configuration, an inversion/reciprocity explanation.

Justification Frequency

As is evident in Table 16, most adequate justification explanations which accompany incorrect judgments are those of the inversion reciprocity type. It should be noted, however, that the particular language used to prompt justification information might have influenced the nature of the explanation given. After each child had given his judgment, he was asked: "How did you know that?" or "How could you tell?" If the child did not respond to this prompting, or if he had given an incorrect judgment, he was more likely to be asked, "How could you make it so that they have the same [relevant attribute]?" or Could you do something to make both [stimuli] have the same [relevant attribute]?"

At posttesting, when more justifications were given by all subjects, the inversion/reciprocity response increased as an explanation of incorrect answers, but also increased as the explanation given to correct answers for both the P and T groups. The most notable change shown in the table is the A group's decrease of inversion/reciprocity justifications to incorrect answers and the concomitant increase of the addition/subtraction justifications, which had been included in the training for this group, to judgments which were now correct. In the pretest for all groups for all concept domains, there were no examples of the spontaneous use of the addition/subtraction justification phrase which was included in the training of the A group, namely, that since nothing has been added or taken away, the stimuli remain the same according to the relevant

dimension. All pretest justifications included in the category of the addition/subtraction justification type were comparisons based on quantity; for example from the conservation of number task, "Cause these are 10 and these are 10," and from the conservation of interior volume task, "they used the same number of blocks."

The Influence of Language Comprehension

Results from studies of child language development provide insight about how children use certain comprehension strategies and operating principles to process information from syntax which they do not adequately comprehend (Chapman, in press). One such strategy is to scan the sentence for individual words with which the child is familiar, and then to apply the meaning of those words to information or performance expectations inferred from the situational context in which they were uttered. Such strategies are quite functional for language acquisition and pragmatic communication in the real world. In task settings, however, such strategies emerge as response biases or preferences, or as task-specific misinterpretations of the intent of the task materials and procedure. This is particularly important when one considers that the judgments which Brainerd (1973, 1977) argues are sufficient to indicate that the child understands conservation of quantity, are "yes" or "no" responses which provide no information about how the child is interpreting the question and how he is integrating his interpretation of the question with the task stimuli before him. The simple response criterion which Brainerd considers adequate is the binary choice given the child to respond correctly with a verbal "yes" or "no" to all of the three conservation questions posed.

It will be argued below that the child will readily use these two words when answering questions directed to him, whether or not he understands the questions, or whether or not he systematically misunderstands them. A child's answer of "no" does not specify what part of the sentence or its referents would have to be changed in order for the child to reply to the question with a "yes." This response also does not necessarily indicate whether the child is actually considering the physical property (or its quantity) which is contained in the question.

When a question containing the word "same" is directed to a child, the child may not interpret it as being embedded in the syntax of the sentence and may not apply it to its specific referent in the sentence. In other words, the child may process the word "same" alone instead of in its intended syntactical context of "same length" or "same number of pennies." For example, in answer to the question, "Are there the same number of pennies here as there are here?" a child replied affirmatively, and when asked to justify his answer said, "Because they are all pennies." For questions about the length of two strings, a child replied, "Yes, because they are both playdough;" another, "They are the same color;" and for a question about interior volume, "Yes; because it is a big house and it is a big house"(indicating each).

Children are not always certain about the exact criteria to use when making judgments of sameness. Most children consider the word "same" to mean complete perceptual identity so that the two stimuli are alike in all physical attributes (Donaldson & Wales, 1970). This fact may have prompted many inversion/reciprocity type justifications. One way of dif-

ferentiating the child's overly constrained interpretation of the word "same" from his conception that the two stimuli are actually quantitatively different when in a different configuration, would be to compare his answer on the "same" question to his answers on the other conservation questions. One example of this:

E: Does this row have the same number of pennies as this row?

S: No.

E: How could you make it so that they have the same number?

(S lines them up exactly in one-to-one correspondence.)

E: Are there more pennies here?

S: No. They are both 10.

E: Are there less pennies here?

S: No. They both have 10.

In another example using the same format a child replied negatively to the "same" question and justified his answer by making the stimuli perceptually identical. In all the other questions about quantity (in this case number), he answered correctly, using such justifications as, "The same amount," and "Cause I didn't take one out of there." Thus it appears that the "same" question is being interpreted as having a particular, constrained, application to such comparisons, even though subsequent justifications indicate that the child understands conservation of quantity.

Another of the child's interpretations of the word "same" is to mean an item's identity over time (Webb, Oliveri, & O'Keeffe, 1974). In response to "same" questions, children reply, "Yes; it's the same thing," or "Yes, because they are all pennies still," "Yes, because you used the

same blocks." This is in complete support of Flavell's (1977) argument discussed below that young children answer conservation questions as though the questions referred to qualitative identity (see also Piaget, 1968a and 1968b). Interestingly enough, it is the word "different" which is applied to comparisons which are exactly the same except for one contrasting attribute (Webb et al., 1974).

It has been established in the child language literature that children only gradually come to understand the correct usage of dimensional adjectives such as "more-less," "long-short," "wide-narrow," etc. (Weiner, 1974; Heidenheimer, 1975). In order to comprehend these terms, children need to be able to further differentiate simple comparisons of size, that is, "big-little," into specific comparisons of attributes so that the terms "long-short," for example, could be applied to the corresponding physical dimension, horizontal extension. Complete understanding of these dimensions, which is a prerequisite to understanding the comparisons requested in conservation tasks, also require the child to be able to use these dimensions in a relative sense, and to use the comparative forms of the words, e.g., "longer-shorter," to refer to corresponding increases or decreases in only that dimension. In the child language studies, children performed so poorly on these initial assessments of their comprehension of dimensional terms that it was originally concluded that they did not differentiate between words which were in fact semantic opposites (Donaldson & Balfour, 1968; Clark, 1972; Klatzky, Clark, & Macken, 1973; Palermo, 1973). However, closer examination of the results showed that, although they did differentiate between the dimensional pairs, their poor performance was

due to response biases (Donaldson & Balfour, 1968; Palermo, 1973), the fact that they did not use the terms "more" and "less" in a relational sense (Donaldson & Balfour, 1968; Donaldson & Wales, 1970), and because it is particularly difficult for children to apply the concept "less" as a mental subtraction when required to judge a stimulus which must diminish according to a specific attribute (Weiner, 1974). The conclusions from these studies which are relevant here are that children may have absolute, as opposed to relative, bases on which to answer questions of comparison using any of these terms. If a child is in the process of acquisition of the terms during which he considers the word "more" to mean "some" or "many," then he may reply to that question on the basis of a comparison to an internalized absolute rather than to a comparison of the two stimuli in relation to each other. Examples from this study include incorrect affirmations of greater quantity because

> "This has much."
>
> "Because this has much space."
>
> "Because here is more, more, more" (i.e., "some," indicating parts of both stimuli).

Another way of using these dimensional concepts in a nonrelational sense is to use the comparative forms of the quantities, e.g., "longer," "heavier," as being absolutes, "long," "heavy" (Maratsos, 1974). Thus questions of relative quantity are interpreted as being questions of appropriate application. Affirmation or negation would then be based on whether the stimulus is really long enough to be considered long, heavy enough to be considered heavy, or as having enough space to function as a house (example used in the interior volume task). In re-

sponse to a question of the relative length of the straight string and the string transformed into a circle: "Is this string longer than this string?" the subject replied, "No." When asked to justify his answer, he replied, "Because I see this one's round and I see this one's long." Thus, it is not semantically appropriate to consider a round stimulus as being long. When asked whether one stimulus (the playdough ball) was just as heavy as the other stimulus (the playdough flattened ball, or pancake), the child replied negatively. His explanation revealed, however, that his reason for this judgment was that both stimuli were "light." In a similar example of the comparative term being used in an absolute sense, three children repeated for several justifications, "They are both longer;" "Those two are longer; see they are both longer," etc. And another child, answering a question of the relative length of two stimuli, said: "They are both the same--this one is long and this one is long."

It is also important to be aware that a child who denies that an item has "more" of a particular dimension may not intend its semantic opposite "less," or even the logical alternative, that the item is thus the "same" in that dimension (Heidenheimer, 1975). And, as in the case with syntax-irrelevant interpretations of the word "same," the child may not apply the terms "more" and "less" to the particular attribute mentioned in the sentence (Donaldson & McGarrigle, 1974). It is this language problem which may partially account for the fact that the child is so easily distracted by differences which are more salient to him, despite the experimenter's repetition of the attribute relevant to the task: "Is this the same length?" "Does this weigh more?" This is one advantage that the

training program had, in that the child's attention could be directed to the relevant attribute by mentioning and contrasting several attributes, such as saying, "This is the same color, but is it the same length?" (see also the previous training studies of Gelman, 1969).

Justifications were seen in many examples to clarify the semantic intent of the judgment. When asked if the flattened stimulus weighs more than the ball, a subject replied, "Yes; the ball is." Or asked if the stimuli were the same, the reply was, "Yes, this has more." A few subjects refused to answer the "yes/no" questions and would express their bases of comparison in an entire sentence which they had constructed themselves. Other justifications clearly negate the judgments as if the child had not interpreted the question properly, or was unaware of the semantic result of his judgment. In future studies, to avoid the "yes/no" response which is so potentially unrelated to the referents contained in the question sentence, one can elicit other simple behavioral responses. The child could be given several stimuli from which to choose, or be encouraged to manipulate the stimuli to conform with the questions or instructions of the task. Thus, with the caveat that one needs to be aware of child language studies which provide data on how children understand certain semantic and syntactic forms as they are in the process of acquiring them, and how children are likely to have task-based strategies and semantic-based strategies to try to comprehend a situation (Chapman, in press), one can devise conservation tasks requiring one-word, or even nonverbal, responses which also indicate the child's level of cognitive functioning.

Justification Showing Qualitative Versus Quantitative Comparisons

Flavell (1977) states that the preoperational child has substantial knowledge about qualitative invariance and about various functions of changes in the quantity of some physical properties. The first invariance concept the child understands is that of qualitative invariance, or the object's retaining its identity over time. A child knows that water poured from one container into another is still the same substance, the same water (Brainerd, 1977; Piaget, 1968b; Papalia & Hooper, 1971). He also knows something about how a physical entity may systematically vary; that is, he can notice both changes in the properties of the object and changes in its quantity. He may know that certain physical changes are always a function of other changes, although he may not know exactly the range of changes which might be criterial or irrelevant for determining a change in quantity. And he may not know that the physical changes which are in a functional relationship with changes in quantity are constrained by invariant, quantitative principles which always apply to increases or decreases in that dimension, no matter what physical object it is an attribute of (Flavell, 1977, pp. 72-79). How well the child understands the functional relationships of certain physical properties depends on the nature of that property. Numerical invariance is less abstract a concept than interior volume, and more easily measured. As the data in this study show, a child may have a definite understanding of the invariance of number, but may not have sufficiently abstracted the concept of logical quantitative invariance to be able to apply it to a more abstract physical property.

Flavell (1977) cites Piaget's data (Piaget, Sinclair, & Vinh Bang, 1968) in concluding that there are steps in the differentiation and learn-

ing of qualitative versus quantitative invariance. The 3-year olds readily asserted the identity of the stimuli no matter what transformations were made in the stimuli; the 4-year olds denied that identity; the 5- and 6-year olds were able to verbally differentiate between a substance retaining its identity as opposed to its quantity when certain attributes were modified; and finally, most of the 7- and 8-year olds understood the difference between the two kinds of invariance and applied their concept of quantity conservation appropriately. Flavell provides a very interesting example of a child's being able to explain, within the limitations of his language ability, the differentiation between physical identity and quantity, or the measurable attribute which manifests that quantity. The task is one of length conservation with one of the wires being transformed into an arc (which nicely avoids the semantic and measurement problems of transforming the stimulus into a circle).

> Yes it's the same wire but it isn't always the same thing; there's one that's longer and one that's shorter. It's always the same, but you keep making it bigger (Piaget et al., 1968, p. 14 as quoted in Flavell, 1977, p. 74).

This provides the insight that it may be qualitative invariance, not quantitative invariance, which was interpreted as being conservation performance in tasks using the transformation of one stimulus over time, quantitative identity, as compared to those using transformations requiring the comparison of two stimuli, quantitative equivalence. But a more important application of justification data which clarify the child's concepts of these invariances and functions is to explicate that amorphous category of the "transitional conserver" by noting the ordered series of approaches children use when solving the conservation problem.

Levels of Justification Adequacy

The data indicate that for future research categorizing, the justifications according to type are not as accurate a description of the child's reasoning as the level of adequacy of the justification which would specify the comparison the child is making and the physical properties and functional dependencies on which it is based.

Inversion/reciprocity justifications, supporting either correct or incorrect judgments, can be nonconservation responses; the child intending: (a) that for the stimuli to be the same one must reestablish perceptual conformity; (b) that there exists qualitative identity, in that, the stimuli are the same stimili as before because even though you have performed a particular action on them, you have not exchanged these stimuli for others; (c) that the particular action or transformation has made the stimuli different and that putting them in their original relationship would make them the same dimension once more. Inhelder et al. (1974) refer to this semilogical justification as being "empirical return" or "empirical reversibility," which is to be distinguished from operational reversibility. The child may know that empirical reversibility effectively negates the changes made in the stimulus, but he does not know what specific actions determine what specific transformations (Inhelder et al., 1974, pp. 33 and 58). The child may not have even abstracted the particular property from the physical stimulus which has been conserved, and has not understood that it was that property which has remained logically invariant despite these physical, but irrelevant, changes.

The justification category of the statement-of-operations performed contains the same levels of adequacy as the inversion/reciprocity justification. Using the operations justification, however, the child instead describes the fact that the physical transformation altered the stimulus. In this study, a simple description of the action performed with no reference to the attributes which might have been altered or to the resultant changes, was not considered an adequate justification.

"Because you split them apart."
"Because you put it down here."
"Because you made it shorter."
"Because it's built bigger now."
"You changed the shape."

An operations justification for a nonconservation judgment in the length task was: "When you move it, you make it longer." One indication that the child understands that invariance of some sort exists is his use of the past tense when referring to the appropriate dimension, "They are the same long because they were the same long," or his use of words implying continuity along with words implying irrelevancies, "Cause, no matter how you move them, it's still the same number," It's just that you made this row a little longer; they both have 10," "You didn't add any to it; you just moved them."

Addition/subtraction justifications can also be at a level less than conservation understanding. A child could use this justification to state a quantitative identity, in that the child understands that some substance must be introduced for quantity to be changed. However, the intended additional quantity may not be of the same dimension. As one child noted, "The ball weighs more; put some wood in it." Most references to addition or subtraction, however, were to more or less of the

same stimulus material. For example, "It's the same long--because it was. Because first it was the same long--and it still is--you couldn't make it longer!" This would be at the level of functional variation, however, because it is based on changes in undifferentiated size or mass rather than increments in the addition or subtraction of a certain property or measurable dimension, as in these examples: "The pancake didn't pick up any," "Take some playdough off," "Put a piece on to the ball." There is also a level of understanding which includes knowing that addition or subtraction of a quantity increases or decreases that quantity, but that other transformations have that effect as well (Wohlwill, 1960). An example from the posttest A group may reflect this level:

E: Is there more space inside the red house than in the white house?

S: No; cause you didn't add any or take any blocks away.

E: Is there the same amount of space inside the red house as in the white house?

S: Yes.

E: How do you know?

S: (No response.)

E: Is there more space inside the white house than in the red house?

S: Yes, right now there is because you made this kind of big.

Another child, answering the same questions, began justifying her answers with, "Cause you didn't add any of these (blocks of red house) to go to these (white house)," and "Cause you didn't add any or take any blocks

away." But in subsequent justifications said, "Cause you builded more on this one," "Cause you added more." Thus this child, having been taught that only addition or subtraction could change quantity, concluded that if the substance appeared to be greater in quantity after a transformation, it had to be the result of having added more material.

The most advanced understanding of conservation is that of knowing the exact nature of the compensation involved (Flavell, 1977; Inhelder et al., 1974; Piaget, 1968b). Quantitative functions are only "one-way dependencies" (Inhelder et al., 1974, p. 34), which, although being covariations of attributes, do not refer to the quantitative compensation of one physical dimension. One child used such covariations in justifying judgments in the conservation of interior volume task, "Cause this one is fatter and this one is skinnier," and "Cause the red (house) is taller and the white (house) is fatter." Another child, supplying a misleadingly correct judgment, said, "This is taller, but it's sort of skinny. This (other house) is fatter so it would have more." In contrast, an operational compensation justification would include reference to an exact, logical, and mathematical (measurable) compensation of a particular quantity which would have to be performed for there to be conservation of that quantity despite other physical changes.

It is this distinction between functional covariation and operational compensation which Bruner's classification of justifications fails to make. As is seen in Greenfield's data (1966), Bruner also makes no distinction in his classification system between empirical return and operational reversibility (Beilin, 1976). By considering only

whether a child mentions the stimulus item or its transformation, the classification system deletes the attribute to which the child refers and that attribute's relationship to the stimulus material before or after transformation. As the examples from this study show, it is not enough to know that the child considers two stimuli "the same" (according to physical properties or physical configuration?), or that one item is "bigger" (according to what criteria?), or that one item has been "changed" (in what attribute, and is that change in attribute relevant to change in quantity?). The child's reasoning itself needs to be classified as well as his specific references to any physical properties and their changing relationships or covariations before and after transformations.

Posttest Justifications of the Group Trained in Conservation

The present study approached conservation learning by attempting to induce the A group children first to focus on the relevant properties of the task stimuli. The relevant properties were mentioned and contrasted to other properties which also defined the item but which were irrelevant to maintaining its quantitative invariance. Then it was stated to the child that relevant changes, i.e., addition or subtraction, of material in the dimension of that property, e.g., length, number, had not been introduced. The results showed that most subjects both learned and adequately justified number conservation. Preoperational children already understand relative increases and decreases in undifferentiated substance or size; their application of this concept after training depended on the physical property involved in the conservation task. The property of numerosity is readily discernible as an attribute of the

task stimuli, especially because the discontinuous substance used is in equal portions, and one can focus on exact increases or decreases in its quantity. Most children gave justifications like these:

E: Are there more pennies here (row)?

S: No. They are both the same. You crunched them up (heap) but didn't take any away or add any.

Another child, articulate in all tasks:

E: Does this row have the same number of pennies as this row?

S: Yes. Even though you spread them apart they are the same. If you take some away there would be less or add some to it, there would be more.

Not all examples were as easy to interpret as being an understanding of quantitative invariance because no addition or subtraction had taken place. One of the few children who did not answer consistently correctly, said:

E: Are there more pennies here (heap)?

S: No. More in row. Because you didn't take any away or add any. (S lines heap in row to reestablish one-to-one correspondence).

E: Are there more pennies here (row)?

S: Yes. Didn't take away or add.

E: Are there the same number of pennies here (row) as there are here (heap)?

S: Yes. Because you didn't take any away.

Thus, one can have "more" (many) pennies, or the appearance of many pennies, without having added or subtracted from their number.

Another example which is difficult to interpret is one in which the child apparently is reasoning at an operational level, in that he has suf-

ficiently generalized the addition/subtraction principle to apply it to the specific amount in this task.

E: Are there more pennies here (row)?

S: No. Because I know there's 10 over here and 10 over there. If you put one here, there's 11, and only (counts) 9 there.

All other justifications given by this child in this task refer to the numerical equality of the stimuli. After one of the questions, he refers to the attribute which might have confused him, in this case, density:

E: Does this row (short one) have more pennies?

S: No. If you put them more close it looks that way, but there isn't. It's the same amount (etc.).

As is shown by this child's responses in the other conservation tasks, however, he is not applying addition/subtraction as an abstracted principle of invariance, but in the number task is relying on the numerical equality of measurable quantity. In the length, weight, and interior volume tasks, he refers to the initial equality, or at least to the "sameness" of the stimuli, but argues that after transformation, the stimuli are not equal. In the length task, he suggests cutting off a piece of the string. In the interior volume task, he refers to qualitative substance ("there's a lot of room in there"), to empirical inversion, and to adding "some more lego," but it does not occur to him to count the lego blocks. Invariance of any kind is not mentioned.

The A group also performed well on the conservation of length task.

E: Is this string just as long as this string?

S: Yes. Cause you made that one into a circle and that one into a line but they are still the same length, cause you didn't add any or take any away.

Another subject:

E: Is this string (straight one) longer than this string (circle)?

S: No. Cause you didn't cut some away. If you cut some you would have a littler string.

Most examples, however, were less easy to interpret. Many correct judgments relied on the fact that the string had not been cut, and that more string, or another string, had not been introduced. That fact was true, however, whether or not the children understood the invariance of the property of length. What the data provide are correct judgments and the repetition for all questions from many subjects, "Didn't add or take away any string." Two subjects used the addition/subtraction principle unambiguously, suggesting cutting off some string to establish equal length.

The conservation of weight task was understood by most A group children as being a conservation of substance, or as a function of quantitative identity, rather than as the invariance of the weight of a substance as determined by the invariance of its quantity despite changes in its shape. Very few children used the terms "weight," "heavy," or "light." Two children who used these terms did not understand the nature of the comparison requested of them: "Both heavy," and "Cause they're still light." Most children made correct judgments and adequate addition/subtraction justifications, but used pronouns rather than referring to the specific property they were considering: "Cause you didn't add any or take any away." Other children were considering substance alone: "Even though you put it in a pancake, it's still the same amount as this," or "They both roll but the pancake is not the same size because it is bigger. Roll it into a ball again." Incorrect answers were justified with inver-

sion/reciprocity reasoning.

Performance on the conservation of interior volume task was best when the task was conceptualized as being another example of number conservation, this time dealing with the number of blocks rather than the number of pennies. Examples of this: "Because this is with the same amount of these (lego blocks)," or "Cause you didn't add any or take any blocks away." Children also consistently answered judgments correctly when they gave justifications without specifying the appropriate referents: "Cause you didn't take any away and didn't add any more." However, in this task, most children made incorrect judgments and supported them with inversion/reciprocity justifications; for example: "Cause this one has more and this one (cube) has less. Unremodel it and make it like this one (cube)." Several children gave answers which showed that they did not understand how to apply the trained addition/subtraction principle to the property in the task. In some cases the correct judgment was given and the correct justification repeated, and then the child would go on to assess the problem using other less relevant considerations. There were four children who showed this complete regression pattern. Each child began with correct judgments and addition/subtraction justifications, and to later questions offered such arguments as:

> "Cause this is a house and this is a building; buildings have more room."
>
> "Cause you builded it way up to there."
>
> "Cause you added more."
>
> "Cause this (transformed) has more room in it."
>
> "Cause a builder made more room in this one."

> "More in the white (transformed) cause its bigger. Make red one (cube) like the white one."

It is not clear from this pattern of response whether the children were using the initial addition/subtraction answers to support only a functional understanding of invariance, that is, that no new lego blocks were added or removed from the quantity already used in both houses in the task, or if they simply could not understand the dimension which was to be abstracted from the task stimuli. Other children's performance on the same task indicate that both conceptual limitations were present.

There was no evidence that the A group children acquired the principle of quantitative invariance which could then be applied logically to any quantifiable dimension. The training was highly successful, however, in teaching the invariance of concept dimensions which the children could identify as physical properties of the task stimuli, such as number and length. These same children who showed that they understood conservation of quantity for those dimensions were only able to learn a functional invariance for the more abstract physical dimensions of weight and volume. One child clearly understood that there was an addition/subtraction principle which could be applied to any substance, but it was not apparent whether that child was aware of the transformations which would influence quantity, especially since all transformations in the task format were always irrelevant to quantity change. This child's reasoning was:

"Even though it doesn't look like it, there is still the same. Only if you add or take some away it will change." and "Even though you change it and it looks different there is still the same amount. No matter how you change."

Justifications as Reflections of Levels in the Acquisition of Quantitative Invariance

From the justification data, levels of adequacy can be isolated as a progressive series of comparisons and reasoning from which children make conservation judgments as they acquire the concept of quantitative invariance. These levels are listed, with examples below:

Levels of Acquisition of Conservation Justification

I. Statements irrelevant to the task. This category is included to show that the child may not always be attending to the comparison of attributes requested of him; indeed, he may not be attending to the appropriate use of the task stimuli at all.

A. Irrelevant information

"I tried it at home."
"I was just guessing."
"Because I used my bionic brain."
S moves pennies in imitation of E, but makes no particular formation.
(interior volume): "So people can live."
"Go inside."
"There's space on top" (roof).

B. Statement of undifferentiated, physically identical appearance

"These are the same and these are different; these are upside down," said as S moved pennies into one-to-one correspondence with all pennies face-up and upright.
"They are the same color."
"They are both playdough."
"They are both purple."

C. Reference to extra-experimental conditions or physical objects, i.e., not the intended comparison.

"The ball weighs more; put some wood in it."
"I would have to dig some dough," (i.e., get more playdough).

II. Statements accompanying judgments which are usually incorrect.

A. Hypotheses based on semantic misunderstanding. Specific examples of the child's misinterpretation of the quantity terms, "same," "more," and "less," and of the dimensional adjectives used were included in the text. The present category refers to changes in the task stimuli which suggested additional physical properties to the child.

1. Circles. It is not semantically appropriate to apply questions of length to circles.

"Because that one is a circle, not a long."
"Circles aren't long!"
"The circle one isn't long any more."
"This (straight) is more longer than that because that is round. This is round! And this is straight!"

2. Pancakes and sausages.

"Because a ball is heavier than a sausage."
"Pancakes are more lighter."
"Cause sausages are light anyways."
"Because pancakes are light."
"Balls weigh more than pancakes."

3. Buildings.

"Apartment buildings are taller than these (cube); that means there is not much room (in cube)."
"Cause this is a house and this is a building. Buildings have more rooms."
"Because I can count the floors of this."

B. Statement of qualitative identity. The child seems to be saying that the material is the same material as before, because one has not exchanged it for new material.

"It's the same thing."
"Cause they are all pennies still."
"Cause you didn't take these away," (indicating entire array).
"Because it had the same ones."
"Because you used the same blocks."

C. Nonverbal establishment of inversion/reciprocity configurations of the stimuli. Inversion and reciprocity were carried out for all task and subtask stimuli for all physical concepts.

D. Statement to return stimuli to initial configuration. These are usually arguments that for the stimuli to be alike in the attribute referred to, they must be maximally similar in physical configuration. This category includes arguments in which no mention was made of the specific dimension involved.

"Put it back in the row like it was."
"If you put them back they would be the same."
"You have to make it into a ball so it will be the same thing."
"Because they were both round in the first place. Make this one round again."
"It's bigger. You would make them the same size."
"Cause this one has less. Put it back."

E. Argument of present or of temporary inequality. This argument frequently contradicts the judgment it accompanies and just as frequently the judgments contradict each other. One must be aware, however, that the child may not be proficient in expressing the differentiation of past and present states, and may not know terms for hypothetical or conditional reasoning. Essentially, in making this argument, the child is saying that some action has made the stimuli different and that putting them in their original relationship would make them the same according to some dimension, whether or not the child is correct in the dimension he states as being influenced.

"If we put these back, there would be the same amount of pennies."
"But if you turn the ball into a pancake it will be the same size."
"More in other. I'd make it into a square cause it'd be the same

space inside."

E: Does this row (long) have more pennies?
S: No, I'd take two from this side (extended row) and that means it's the same number."

E: Does this (ball) weigh more than the sausage?
S: Yes, but if you turn that into a sausage it will weigh the same as the sausage.

E: Is there the same amount of space inside the red house (cube) as in the white house?
S: Yes.
E: How do you know?
S: Because I know it has the same size. But that one (transformed) has a little more.
E: Is there more space inside the red house (cube) than in the white house?
S: Yes. Because its the same size. Because I know there's the same thing.
E: Same what?
S: But first you have to cut this piece off.
E: Show me.
(S makes transformed house into cube.)

F. Comparison based on dimensional criteria. This category includes the child's attempts to deal with physical dimensions and their relationships.

"This is taller, but it's sort of skinny. This (cube) is fatter so it would have more."
"Because it's higher and there is more space."
"Cause when it's bigger it has more space."
"They are both the same size but this one is bigger."
"Cause you made that wider and bigger."

E: Does this row (short) have more pennies?
S: Yes. Because that row (short) are close together. I would put the long row back how it was."

"The round one is lighter than the flat one."
"More, because pancake has more scattered around; make the pancake into a ball."

III. Statements accompanying judgments which are usually correct.

A. Arguments based on equality at initial configuration, including mention of the appropriate dimension. The child states that the

stimuli are the same because they were the same.

"It's the same long because it was."
"Cause they were in a line and there was the same amount of pennies."
"When it was a straight line, it was the same length. They are the same length again, like before."
"Because they were the same length."
"Cause you moved it up and if you move it down it will be the same length."

B. Making correct judgments when attending to the appropriate dimension, but making incorrect judgments when attending to another dimension.

E: Does this row (long) have more pennies?
S: No. Cause I'll count. Cause it only has eight.

(Same S later in task answers three out of three judgments correctly, saying: "They are both 10.")

E: Does this row (short) have more pennies?
S: (counts correctly) "There's 10 in each row."
E: Does this row (long) have more pennies?
S: Yes; make this as long as this one.
E: Does this row have the same number of pennies as this row?
S: Yes. Because those are just spread out.

E: Are there more pennies here (heap)?
S: No. Because you didn't take any away or add any. More in row. (S lines heap into row.)

E: Does this row (long) have more pennies?
S: No. No matter how you move them it's still the same number.
E: Does this row have the same number of pennies as this row?
S: No. You could get a few more pennies and put them here (S indicates the ends of shorter row).

E: Does this (sausage) weigh more than this (ball)?
S: Yes. Put this one back into a ball.
E: Does the piece of playdough (sausage) weigh just as much as this piece (ball)?
S: Yes. They were both in a ball in the first place. They were the same size and the same weight.

E: Is there more space inside the red house (cube) than in the white house?
S: No. Cause you didn't add any or take any blocks away.
E: Is there more space inside the white house than in the red house (cube)?
S: Yes. Right now there is because you made this (cube) kind of big.

IV. Statements accompanying consistently correct conservation judgments.

A. A comparison based on quantity and/or other dimensions.

"Cause I didn't take one out of there."
"Cause these are 10 and these are 10."
"That one has as much playdough as that one."
"There's the same amount, but only it's different shape."
"Cause you didn't cut some away. If you cut some you would have a littler string."
"They weigh the same unless you take some off one and put it on the other."
"These were the same amount of blocks and you used all the same blocks in this one."
"Cause you didn't add any or take any blocks away."
"Because they're different colors, shape, but still the same space."

B. A statement that the physical operation performed is irrelevant, and usually including reference to initial equality.

"It's just that you made this row a little longer. They both have 10."
"They are both the same. You crunched them up but didn't take any away or add any."
"Even though you spread them apart they are the same. If you take some away there would be less or add some to it, there would be more."
"We measured them--they were the same and then you just turned the top one into a circle."
"Because even though you put it in a sausage it still weighs the same. If you take some then it won't."
"No matter how you move the string, it's still the same length."

C. A logical argument of quantitative invariance under all circumstances despite certain irrelevant changes. Only one subject is included in this category. After training in the A group, she answered all judgments in all tasks correctly.

"Even though you change it and it looks different, there is still the same amount. No matter how you change."
"Even though it doesn't look like it, there is still the same. Only if you add or take some away it will change."

D. A logical argument of the compensation of invariant quantity.

There were no examples in this category.

Summary

As discussed above, the justification data indicated: (a) that young children are likely to make judgments based on information and hypotheses irrelevant to the comparison required in the task; (b) that a given child can use more than one basis of comparison to make his judgment; (c) that the most likely justification to an incorrect judgment is an inversion/reciprocity, or empirical return, argument because children understand that two items' being the same in a particular way is a function of their being maximally the same in all attributes; (d) that children progress through levels of adequacy in any or all justification types; (e) that attention to the covariation of two attributes may be more advanced than other justification arguments, but that a statement of logical compensation can be arrived at from reasoning based on any of the justification types; (f) that the more abstract the physical concept of the task, the more likely the child is to revert to the inversion/reciprocity argument; and (g) that, from the A group data, the addition/subtraction argument is very efficient in helping the children to attend to the relevant attribute of a given task and to ignore changes in configuration of that attribute when making judgments about quantity.

VI

DISCUSSION

The general lack of any pretest differences among the three preschool groups permits a direct comparison of the posttest, pretest/posttest changes, and delayed posttest response patterns. The present test battery which is generally reliable in terms of pretest internal consistency (see pages 51 and 52) has revealed a number of important distinctions between the two experimental conditions (Ausubelian and Piagetian) and the traditional (control) condition. The posttest score analyses indicated significant experimental condition versus control group differences (Contrast I) favoring the former programs on dichotomous sorting, multiple classification, serial ordering, additive seriation, serial correspondence, and number, weight, and interior volume conservation tasks. In contrast, no significant distinctions were found for the posttest RCPMT and PPVT standardized test scores. Superior Ausubelian condition scores compared to the Piagetian preschool children (Contrast II) were found for conservation of weight, number, and length.

The repeated measurement ANOVAs revealed a generally concordant pattern of differences which are marked by experimental group superiority. As anticipated, the time of measurement factor (with increased posttest scores) was significant for the majority of the logical reasoning tasks and the two standardized tests. Contrast I main effects were significant for dichotomous sorting, total seriation, and number, length, and inter-

nal volume conservation. Contrast II main effects (favoring the Ausubelian children) were significant for class inclusion, number, and occupied volume conservation. A number of contrast x time of testing interactions were significant, indicating differential score changes favoring the experimental group children. While multiplicative classification and seriation were seen to be of equivalent item difficulties (in agreement with the Genevan position), transitive inference was found to be significantly easier than conservation of length.

The delayed posttest results indicated definite stability of learning for the Ausubelian group, and general superiority of performance compared to the control (traditional preschool) children's scores. In two cases, i.e., class inclusion and occupied volume conservation, the delayed posttest score distinctions indicated Ausubelian group superiority which were not significantly present at the time of initial posttesting. Thus, the demonstrated stability and later score superiority would appear to meet Piaget's (1964) criterion for genuine cognitive growth following experimental intervention/enrichment.

It would seem to be the case that while both experimental groups are distinctly superior to the control groups performances these distinctions are particularly notable for the children participating in the Ausubelian program. In three instances the Ausubelian children's conservation score patterns were significantly higher than those of their Piagetian counterparts. In addition, the interim or midyear assessments, which compared the two experimental group performances, revealed a preponderance of Ausubelian higher scores and laid emphasis to the

role of content considerations in conjunction with process/operations teaching objectives. It is clear that, in the short run at least, the Ausubelian program is more efficacious. This is particularly true of the conservation task domain which lends itself more straightforwardly to algorithm or "rule" type learning as represented in the present advance organizer constructs (e.g., Beilin, 1965; see also the results concerning the various types and changes in conservation explanation frequencies, i.e., Table 16).

The present task interrelationship analyses (i.e., factor analysis: see pages 73 to 76) are of course tentative but they generally tend to indicate a nonunitary picture of cognitive structure for a small sample of children currently making the "transition" from the preoperational to the concrete operations periods of development. In essential agreement with Hooper et al., 1976, separate conservation, classificatory, and relational concept factors were observed. The standardized measures (especially the RCPMT) were more closely associated with the classificatory factor and this would appear to agree with the earlier Genevan contentions, e.g., Inhelder and Piaget (1964).

In summary, these results support the efficiency of structured (Ausubelian and Piagetian) early childhood education programs in promoting development and improving short-run competencies. If structure is described as the degree of teacher initiated, adult-child, and child-material interactions (e.g., Day, 1977; Featherstone, 1973; Mayer, 1971), in general the quality of children's performance on the test batteries used in this study improved in relation to program structure. Perhaps

one important feature of structured learning is that, under such conditions there is more chance the child will remain attentive and spend more time on each task. When this occurs the liklihood of improvement is enhanced.

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APPENDIX A

SAMPLE ACTIVITY PLANS AND ACTIVITIES FOR THE PIAGETIAN AND AUSUBELIAN PROGRAMS

SAMPLE ACTIVITY PLAN AND WEEKLY SCHEDULE

FOR THE PIAGETIAN PROGRAM

ACTIVITY PLAN
FINGER PAINTING WITH SAWDUST

A. Objective for Children

1. Behavioral Objectives:

a. Children will use primary colors separately.

b. Children will mix primary colors to make green, orange, and purple.

c. Children will paint with smooth paint.

d. Children will add sawdust to finger paint.

2. Theoretical Objectives:

a. Classification by color; texture (smooth vs. bumpy) when sawdust is added; things that are needed to finger paint (e.g., special paper, water to make paper wet, tongue depressor for getting paint, finger paint, smock, etc.).

b. Relations: recognition of darker and lighter shades of primary colors when more water is added to paper or when different proportions of primary colors are mixed to form secondary colors; recognition of varying textures (smoother, bumpier) when increasing amounts of sawdust are added to the finger paint.

c. Number: making gross comparisons between a lot of finger paint and a little bit, a lot of sawdust and a little; noticing whether or not each child has a piece of paper or his own paint (using one-to-one correspondence).

d. Preconservation: notion of reversibility--can sawdust in finger paint be **retrieved and returned to its original form?**

e. Time: mixing two primary colors together in order to make a secondary color (making secondary colors in a means-end sequence).

f. Representation: using body movements (i.e., fingers, hands, **etc.), to make pictures or designs in paint; using sawdust** to represent, for example, rain or popcorn.

g. Conventional knowledge: practice in asking for paint or for help, putting on paint smock before painting, painting on one's own piece of paper, calling colors by appropriate names.

h. Physical knowledge: experience in making smooth vs. rough textures and in mixing paints to make new colors; patting, squeezing, smelling, tasting paint in order to determine its properties; asking questions such as "What will happen if I mix blue and red and yellow together?" or "What will happen to the finger paint if I add sawdust?" and hypothesizing answers to these questions.

i. Socio-emotional development: cooperation in use of and sharing of paints; asking questions and participating in conversations with adults and peers at art table.

j. Psycho-motor development: eye-hand coordination in putting paint on tongue depressor and then on paper; use of fingers, hands, elbows, arms, etc. in painting; squeezing clothespin in order to hang up finished painting; washing off paint from hands, etc. when cleaning up.

B. Objectives for Teacher

1. Participate in activity with children.

2. Be ready to interact by providing help, asking questions, and rearranging materials in order to stimulate thinking, e.g., "What are the things we need for finger painting?" (classification); "What will happen if you put more red than yellow in the red and yellow mixture?" (relations); "Are there enough pieces of paper for everyone at this table?" or "Do we have enough paint for everyone to have his own jar?" (number: one-to-one correspondence); "What does the sawdust feel like?" (representation); and placing only one tongue depressor in each finger paint jar to encourage sharing (socio-emotional); putting too few chairs at pieces of paper at the table so children will realize they need more (and will have to figure out how many more are needed by one-to-one correspondence and counting); providing clothespins and clothesline within reach of children and encouraging them to try to help hang up their pictures (psychomotor ability in using clothespins, socio-emotional growth in the pride in hanging up one's own paper).

3. Provide more paint, paper, etc. when needed.

C. Location in Room: Art area, at tables nearest to sink.

D. Materials

1. Finger paint (three colors--red, blue, yellow; two jars of each color)
2. Tongue depressors (for distributing paint; one for each jar)
3. Finger paint paper (at least 24 sheets)
4. Magic marker (to write child's name on paper)
5. Wet sponge (to wet paper before painting)
6. Eight paint smocks

7. Bucket of water with sponge (for clean-up)
8. Two long tables, pushed together
9. Four chairs
10. Newspapers (and tape) to cover tables
11. Clothesline and clothespins (for hanging up finished paintings)

E. Procedure:

1. Set up and Introduction

Tables will be designated for painting by taping newspapers down before children enter the area; paint jars, tongue depressors, sponge, paper, and magic marker will be on art tables; 4 smocks will be hung on 4 chairs pushed up to tables; other materials will be on nearby small table; one teacher will be sitting at the art tables painting or mixing colors before any children start painting.

2. Method

A maximum of eight children will be able to paint at one time; they will put on a smock before painting and paint at a designated place at the tables with their own piece of paper marked with their names; when each child is finished, he will hang up his painting (with help of another child or teacher, if necessary) and go to the bathroom to clean up; each child will replace his smock on a chair or on the extra materials table.

3. Conclusion

When children have finished painting or when it is time to put activity away, teachers and children will place materials on counter, remove newspapers from tables and throw them away; teacher will help children check their drying papers, wash tables if necessary, and wash and put materials away after school.

F. Evaluation: Completed after activity.

Week of October 6-9, 1975

FOREST HOMES: CHIPMUNKS, SQUIRRELS, RABBITS, BIRDS, INSECTS, SPIDERS, AND WORMS

Time	Monday Teacher Observer: Carol	Tuesday Teacher Observer: John	Wednesday Teacher Observer: Jan	Thursday Teacher Observer: Sally
12:45 - 1:15 P.M.	Class Meeting Time followed by Small Groups	Class Meeting Time followed by Small Groups	Class Meeting Time followed by Small Groups	Class Meeting Time followed by Small Groups
1:15 - 2:15 P.M.	Free Rotation: Art (John): 1) Weaving spider webs 2) Egg carton spiders Active Area (Sally): Woodworking--making spider web frames Quiet Area (Jan): 1) Insect exhibit 2) Insect books Dramatic Play (Beth): Forest homes Snack (Beth): Nuts, berries, & juice Organic Reading (Jan)	Free Rotation: Art (Sally): 1) Forest animal puppets 2) Forest collages Active Area (Carol): 1) Hollow blocks 2) Puppet stages Quiet Area (Beth): 1) Repeat Monday's activities 2) Mounting insects 3) Making insect books Science (Beth): Magnifying glasses Dramatic Play (Carol): Repeat Monday's activity Snack (Jan): Marshmallows, pretzel sticks, & juice	Free Rotation: Art (Beth): Making worm terrarium Cooking (Beth): Worm food Outside (Beth): Digging for worms Active Area (no teacher assigned): Hollow blocks Quiet Area (John): 1) "Parts of insects' puzzles 2) Cootie game Dramatic Play (Carol): Repeat Tuesday's activity Snack (Sally): Sunflower seeds, blueberries, & juice	Free Rotation: Art (Beth): 1) Making bird nests 2) Making bird families Outside (Beth): Repeat Wednesday's activity Active Area (no teach. asgnd.): Repeat Wednesday's activity Quiet Area (Jan): 1) "Feely" box with natural materials 2) Repeat Wednesday's activity Dramatic Play (John): 1) Filmstrips on insects and birds 2) Repeat Wednesday's activity Science (Jan): Bird nests with magnifying glasses Snack (Carol): Peanut butter filled celery & juice
2:15 - 2:30 P.M.	Clean-up	Clean-up	Clean-up	Clean-up
2:30 - 2:50 P.M.	Large Group (Beth): Forest animal songs & finger plays	Large Group (Beth): Movie--"Adventure of a chipmunk family"	Large Group (Beth): Forest band (instruments) & animal songs from Monday	Large Group (Beth): Creative dramatics--"In the forest"

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EXAMPLE OF A WEEKLY ACTIVITY CHART

FOR THE PIAGETIAN PROGRAM

EXAMPLES OF REPRESENTATIVE ACTIVITIES

FOR THE PIAGETIAN PROGRAM

The purpose of this appendix is to present a few examples of the way in which activities are planned. It is not intended to supply a list of activities that, when carried out in a classroom, will ensure a "Piagetian" program. What makes a classroom "Piagetian" is the act of exhausting all the possibilities the activities may possess in terms of the theory and the children's levels of development. It is the thinking process that the teacher, and subsequently the children, must experience that is the critical factor, not the activity itself. The usefulness of these activities, therefore, will be minimal for any other teacher. The activities that are the most useful are those which the teacher has constructed himself.

ACTIVITY 1

Snack--Marshmallows and Pretzel Sticks

Materials: Bowls of pretzel sticks and rods, bowls of different sized and different colored marshmallows.

Theoretical Objectives:

1. Physical Knowledge:

   a. The ability to make predictions about the strength of the pretzel sticks when pushed into the marshmallows (for example, a thin, short stick will break when it is pushed into a large marshmallow) and the strength of the marshmallows.

   b. Knowledge of the properties of marshmallows (soft, sweet, etc.) and pretzels (crunchy, salty, weak).

   c. A repertoire of actions that can be performed on pretzels and marshmallows (for example, they can be broken, smashed).

2. Classification:

   a. The ability to group all the like foods one wishes to eat (only the pretzel sticks, only the big, green marshmallows).

   b. The ability to choose a criterion for grouping (color, size, length, the pretzels that look like legs).

   c. The ability to choose only those foods that conform to the criterion decided upon.

   d. The ability to sort one's own selection of pretzels and/or marshmallows exhaustively into dichotomous or multiple groups.

   e. The ability to regroup one's own collection of pretzels and/or marshmallows (for example, all the pretzels vs. all the marshmallows becomes all the big things we eat vs. all the little things).

   f. The ability to group pretzels and/or marshmallows on the basis of two or more simultaneous attributes (for example, all the pretzels that have the salt rubbed off and are broken).

3. Relations:

   a. The ability to recognize the difference in sizes of the marsh-

mallows and lengths and widths of the pretzels.

b. The ability to sort one's collection into dichotomous groups (for example, all the pretzels that are thicker and thinner than one particular pretzel).

c. The ability to order pretzels and marshmallows on the basis of size, length, and width.

d. After making several orders, the ability to construct one-to-one correspondences between the ordered groups (for example, the littlest marshmallows with the thinnest pretzel sticks).

e. The ability to insert additional pretzels or marshmallows into the original sequences.

4. Number:

a. The ability to make comparisons among the amounts of the various pretzels and the marshmallows, that is, a lot of pretzel sticks and a small amount of pretzel rods.

b. The ability to compare groups of foods exactly through one-to-one correspondence (for example, putting one pretzel stick into each marshmallow in order to determine if there is the same amount of pretzels and marshmallows).

c. The ability to understand the effect of adding and subtracting (eating) pretzels and marshmallows in order to see groups getting larger or smaller.

d. The ability to realize the equivalencies between two groups regardless of spatial considerations (for example, a group of miniature marshmallows and a group of large marshmallows may be equal in number, although the large ones take up more space and provide a greater amount of marshmallow to eat).

5. Spatial Understanding:

a. Continuity: The ability to build, for example, roads or stepping stone paths with pretzels and marshmallows that are straight, curved, or bent, but which start in the same place and end in the same place.

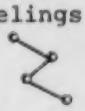
b. Enclosure: The ability to construct two and three dimensional figures with the pretzels and marshmallows that enclose space or have openings in the borders (for example, atoms or).

c. Separation: The ability to construct figures from pretzels and marshmallows, taking them apart and putting them back together again in a different form or constructing similar figures using different parts (for example, and).

d. Order: The ability to make and copy patterns of marshmallows and pretzels identically in terms of the direction and sequence of the pattern.

e. Quantifying Distance: The ability to determine, for example, the number of pretzel sticks that equal in length and width a pretzel rod.

6. Representation:

The ability to use the pretzels and marshmallows as substitutes for real objects or feelings (for example, animals such as or lightning ).

ACTIVITY 2

Map Reading

Materials: Picture "map" of familiar areas in the classroom or the outside area.

Method: This can be used in a variety of ways. One way is to draw footsteps going off the map leading to a treasure. The children have to follow the footsteps to find the treasure. This works best when not more than two or three children have the same map.

Theoretical Objectives:

1. Representation:

   The ability to understand that the pictures on the map stand for the real objects in the room or outside; the footsteps represent their footsteps.

2. Number:

   The ability to take an equal number of steps according to the map coordinate by using one-to-one correspondence, that is, taking one step for each footstep drawn.

3. Spatial Understanding:

   a. Continuity: The ability to use the map as but one route to an end point, and to realize that other maps with differing routes may be used to reach the same end point.

   b. Separation: The ability to distinguish the parts of the map (that is, the drawings of the objects, furniture, etc.) from the map as a whole, in order to use those parts as coordinates.

   c. Proximity: The ability to make judgments of distance or location by using drawings on maps as reference points.

   d. Quantifying Direction: The ability to notice the degree of directional changes that the map directs.

   e. The ability to notice different viewpoints presented by using different maps, that is, two different maps may lead to the same end (treasure) but the route for each is different.

ACTIVITY 3

Treasure Hunt

Materials: Pictures (hand-drawn) of salient objects, materials, furniture in the classroom or outside (the number of pictures to use depends on the familiarity of the game, the developmental status of the children, attention span, etc.), and envelopes in which to put pictures.

Method: Clues (the pictures in their envelopes) are placed around the classroom or outside and the children follow them to an end point, treasure, etc.

Theoretical Objectives:

1. Representation:

   Ability to recognize that the pictures stand for the real objects, materials, and furniture in the preschool environment.

2. Pre-classification:

   Ability to match the picture clue with the identical object.

3. Temporal Sequencing:

   Ability to follow the sequences of the clues in order as a means of obtaining the "teasure" at the end of the hunt.

VARIATION OF ACTIVITY 3

Missing Person Hunt

Materials: In addition to the above "clues," a piece of cut-up photograph of one of the children may be placed in each envelope. As the clues are gathered, so are the picture pieces, which can be put together at the end of the treasure hunt.

Theoretical Objectives:

1. Number:

   Ability to notice that the effect of adding a picture piece as a clue is found is to increase the number of photograph parts.

2. Spatial Understanding

   a. Separation: Ability to assemble the picture pieces in order to construct a whole.

   b. Proximity: Ability to use facial and body features as clues for reconstructing the picture, that is, the pieces are placed at a certain distance and in a certain position in relation to each other.

ACTIVITY 4

Wrapping Boxes

Materials: Boxes that are different in size and shape, pre-cut sheets of wrapping paper, an uncut roll of wrapping paper, and masking tape.

Theoretical Objectives:

1. Physical Knowledge:

   Knowledge about the properties of paper (crumbles, tears, etc.) and of tape.

2. Preconservation:

   The ability to recognize the reversibility of the act of wrapping by unwrapping the boxes as well.

3. Relations:

   a. The ability to recognize the relative differences in sizes of the boxes and sheets of wrapping paper.

   b. The ability to use transitive reasoning to determine which size of the sheets of wrapping will fit a particular box (for example, if box X is wrapped with paper sized A, and box Y is equal in size to box X, then wrapping paper sized A should fit box Y as well).

   c. The ability to order a series of boxes by size and a series of wrapping paper sheets by size.

   d. The ability to determine which size wrapping paper will fit which size box by constructing one-to-one correspondences between the series of boxes and the series of paper sheets.

4. Number

   The ability to determine whether or not there are enough sheets of wrapping paper for the number of boxes by placing the boxes and wrapping paper sheets in one-to-one correspondence. If more is needed, enough sheets can be cut from the roll of wrapping paper.

5. Spatial Understanding:

   a. Enclosure: The ability to wrap the paper around the box, so that the box is "inside" and the paper is "outside;" to close the paper around the box, noticing the edges of paper in relation to the box; and to notice the closing edges of the paper that prevent the box that is inside from being seen.

   b. Proximity: The ability to place the wrapping very close to the edges and surfaces of the box.

ACTIVITY 5

"I See Something"

Method: A small group of children are seated together. The idea of the game is for each child, in turn, to look at something in the room without saying what it is, and to give "clues" in order for the other people in the group to determine what it is.

Theoretical Objectives (for clue-giver):

1. Classification:

   The ability to discriminate and choose attributes of an object to serve as a "clue" to its identity.

2. Conventional Knowledge:

   The ability to use verbal communication skills in a manner that facilitates decentration.

Theoretical Objectives (for the clue-receiver):

1. Classification:

   The ability to organize and group related attributes (clues) into a whole.

2. Conventional Knowledge:

   The ability to understand the verbal communication skills of others (decentration).

ACTIVITY 6

Apples and Worms

Materials: 5 cardboard apples (2 red, 2 green, and 1 yellow) in each of 6 sizes, with one hole punched in each; 5 worms (2 brown, 2 orange, and 1 gray) in each of 6 sizes; extra worms (2 black) and apples (2 pink). Both the extra worms and apples should be different sizes from the original 5.

Theoretical Objectives:

1. Classification:

   a. The ability to note similarities and differences among the apples (size, color, apples I like) and worms.

   b. The ability to match identical apples and worms.

   c. The ability to choose criteria for grouping (for example, group apples by size or by color).

   d. The ability to sort apples and worms consistently into groups.

   e. The ability to shift criteria for grouping, for example, grouping apples by size first and then grouping them by color.

   f. The ability to group apples and worms according to two or more simultaneous attributes (for example, big and gray worms, big and orange worms).

2. Relations:

   a. The ability to recognize differences in sizes among the apples and among the worms.

   b. The ability to find all the apples or worms bigger than or smaller than apple X or worm Y.

   c. The ability to use transitive reasoning to determine the relative sizes of apples or worms.

   d. The ability to order the worms and the apples by size.

   e. The ability to construct one-to-one correspondences between the apples and worm series.

   f. The ability to insert extra worms or apples into the series.

3. Number:

   a. The ability to make exact comparisons between the amounts of apples and worms through one-to-one correspondence (provoked).

   b. The ability to understand that taking away worms or apples makes fewer; adding them makes more.

   c. The ability to conserve the number of worms and the number of apples when the configuration is changed (for example, worms lined up vs. worms in a pile).

   d. The ability to conserve the equivalence of apples and worms when the arrangements are changed (for example, apples arranged in a pile in a basket vs. worms spread out under the ground).

ACTIVITY 7

Crayon Melting

Materials: Broken chunks of crayon (different colors), miniature muffin tins, and a toaster oven (preferably with a window).

Method: Crayon pieces are combined in any way children like in the tins, then placed in the toaster oven and remade into new crayon chunks.

Theoretical Objectives:

1. Physical Knowledge:

   a. The ability to make predictions about the crayons in the toaster oven, for example, concerning the effect of heat on the form or shape of the crayon, the color of the final product if more than one color of crayon is combined in each tin.

   b. Knowledge about the effect of heat on solids (crayons).

2. Preservation:

   The ability to recognize the property that is changing (for example, the discrete crayon pieces) and the property that remains unchanged (the amount of crayon).

3. Classification:

   a. The ability to sort all the crayon pieces into groups (for example, by placing the same colored crayon pieces in a tin).

   b. The ability to regroup the crayon pieces to form new groups (form groups by color, then groups by similar-sized pieces).

   c. The ability to group crayons on the basis of two or more simultaneous attributes (for example, big, red pieces).

4. Relations:

   a. The ability to notice the relative difference in sizes of the crayon pieces or between the melting stages (degrees of softness).

   b. The ability to arrange crayon pieces in order in the tins by relative sizes.

   c. The ability to insert extra or additional pieces of crayon into already constructed series.

5. Number:

   The ability to compare the number of crayon pieces in one tin with another tin, grossly (a lot, a little) and exactly through one-to-one correspondence between crayon pieces.

6. Spatial Relations:

   Separation: The ability to notice the effect of adding together many crayon pieces to make a new crayon (this involves number skills as well).

7. Temporal Understanding:

   The ability to recognize the distinction between the pieces of crayon preceding the final crayon chunk, and the heat affecting the change (temporal order vs. efficient causality).

ACTIVITY 8

Paper Doll Cut-Ups

Materials: Six 5"-8" paper doll figures (may be purchased commercially or constructed) with the body parts cut (i.e., legs, arms, hands, feet, trunk, head, hair, etc.), envelopes for each complete set of paper doll parts, and extra body part pieces.

Theoretical Objectives:

1. Classification:

   a. The ability to recognize similar and different body parts and the sizes of the parts.

   b. The ability to match and group similar body parts and similar sizes of body parts.

   c. The ability to select criteria for grouping body parts (hands, trunks, toes, end parts, such as feet, hands, and hair, parts that make a whole person, etc.).

   d. The ability to sort body parts consistently according to criterion selected.

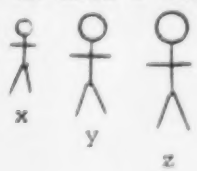
   e. The ability to use all the body part pieces available in making dichotomous groups or multiple groups.

2. Relations:

   a. The ability to notice differences in sizes among the body parts and completed doll figures.

   b. The ability to find all the figures larger than or smaller than figure X, or all the body parts larger than or smaller than body part X.

   c. The ability to explain, using transitive reasoning, that, for example, doll X is smaller than doll Z, knowing Z's relationship to doll Y and doll X's relationship to doll Y:



d. The ability to order the paper dolls or body parts according to size.

e. The ability to construct one-to-one correspondences between ordered series of body part pieces.

f. The ability to insert an extra body part piece into constructed series.

3. Number:

a. The ability to construct one-to-one correspondences of body parts (for example, one hair piece with one head or one foot with one leg).

b. The ability to conserve the number of heads, hair pieces, trunks, etc., in spite of physical arrangement of the pieces.

c. The ability to conserve the equivalence of two groups of body parts (heads and hair pieces, etc.) in spite of physical arrangement of pieces (that is, not arranged in perceptual one-to-one correspondence).

4. Spatial Relations:

a. Separation: The ability to reconstruct paper doll figures from the available parts.

b. Proximity: The ability to place the body parts in the correct positions in relation to each other.

5. Conventional Knowledge:

The ability to name or recognize the body parts.

ACTIVITY 9

Tasting Game

Materials: Tray, paper cups (3-ounce size), spoons, toothpicks, a variety of food products chosen for their tastes and textures, such as: (1) sweet: chocolate chips (semi-sweet, milk chocolate), sugar cubes, marshmallows, life savers; (2) tart: orange, lemon, grapefruit, lemon drop; (3) tangy: peppermint candy, gum, toothpaste, cinnamon drop; (4) crispy: celery, carrot, apple, lettuce; (5) soft: strawberry, banana, cooked potato, peanut butter; and (6) salty: pretzel sticks, potato chips, salt.

Theoretical Objectives:

1. Classification:

   a. The ability to focus on similarities and differences in taste and texture of foods.

   b. Ability to group some foods by shared tastes and/or textures (for example, apple with pretzel--crunchy; strawberry with toothpaste--soft).

   c. Ability to select criteria for grouping (for example, soft foods, sweet foods).

   d. Ability to use criteria selected for sorting consistently (for example, grouping all the sweet foods or all the crunchy foods).

   e. Ability to sort all the foods on the basis of criteria selected into dichotomous groups (all the sweet foods and all the foods that are not sweet) or multiple groups (the sweet foods, the tart foods, and the tangy foods) with no foods left over, that is, not in a group.

   f. Ability to regroup foods once initial categories have been made (for example, an apple grouped according to a criterion of a crunchy food may be put into a group of sweet foods; a salty pretzel is put into a group of crunchy foods).

   g. Ability to group foods on the basis of two or more simultaneous tastes and textures (for example, crispy and salty foods in one group; sweet and soft in one group).

2. Relations:

   a. Ability to notice relative differences among foods in terms of

taste and texture (soft strawberry, softer peanut butter).

b. Ability to serially order foods on the basis of taste and/or texture (for example, sugar cube, milk chocolate, semi-sweet chocolate; lemon drop, grapefruit, lemon).

3. Conventional Knowledge:

The ability to recognize and/or use the terms commonly used to describe various tastes and textures (sweet, soft, crunchy, salty).

ACTIVITY 10

Mounting Insects and Spiders

Materials: A variety of different and same insects and spiders, mounting pins, and a flannel board on which to mount the insects.

Theoretical Objectives:

1. Physical Knowledge:

   a. Knowledge about the properties of insects and spiders (body parts, number of legs, texture, relative sizes) from investigating them and taking them apart.

   b. Ability to make hypotheses about the properties of insects or spiders (use of antennae, wings, etc.).

   c. Knowledge of actions useful for finding out about insects and spiders (for example, smashing insects destroys them and prevents further investigation, watching ants in the ground will reveal social life of ants, reading a book will provide information about foods that various insects and spiders eat, etc.).

2. Preclassification:

   Ability to focus on similarities and differences among insects and spiders (number of legs, winged vs. wingless, three-part vs. two-part body).

3. Classification:

   a. Ability to choose criteria by which to arrange (group) spiders and insects on the flannel board (for example, insects vs. spiders, winged vs. wingless insects, insects one has seen vs. those one has never seen before).

   b. Ability to group the insects and spiders consistently according to selected criteria into dichotomous or multiple groups.

   c. Ability to regroup insects and spiders on the basis of new criteria (for example, winged vs. wingless groups become spotted vs. spotless groups).

   d. Ability to group insects and spiders on the basis of two or more simultaneous attributes (brown insects that have wings).

4. Relations:

   a. Ability to recognize differences in sizes among insects and spiders.

   b. Ability to sort insects and spiders according to size differences.

   c. Ability to serially order insects and spiders on the basis of a relative attribute (for example, size, number of spots, number of wings).

   d. Ability to insert extra insects and spiders into already constructed series.

5. Number:

   a. Ability to make exact comparisons between insects and spiders (number of wings, spots, body parts, legs, etc.) using one-to-one correspondence.

   b. Ability to notice that additional legs, spots, etc. of one insect when compared with another means the first one has more, or vice versa.

6. Spatial Relations:

   a. Separation: Ability to recognize that the parts of insects and spiders may be arranged differently for each, but they always make a complete insect or spider.

   b. Proximity: The ability to recognize the relative positions of each insect or spider body part in relation to the other parts (for example, antennae on the head, wings on the thorax).

7. Conventional Knowledge:

   a. Ability to recognize and use the names of the insects and their body parts.

   b. Ability to use the words describing the locations of the insect and spider body parts (for example, on, under, on the side, on the end, etc.).

SAMPLE ACTIVITIES FOR THE AUSUBELIAN PROGRAM:

CONTENT/PROCESS ADVANCE ORGANIZER LESSONS AND RELATED ACTIVITIES

EXAMPLE OF WEEKLY SCHEDULE

		Monday	Tuesday	Wednesday	Thursday
Science (Monday and Tuesday)	1st	1 (1)	2	1	2
Communication (Wednesday and Thursday)	2nd	3	4	3	4
Social Studies (Monday and Tuesday)	1st	2	3	2	3
Art (Wednesday and Thursday)	2nd	4	1	4	1
Skills	1st	4	1	4	1
	2nd	2	3	2	3
Application & Evaluation	1st	3	4	3	4
	2nd	1	2	1	2

(1) Children are divided into four groups for AO and RA lessons. The schedule outlined above ensures that all children receive AO and RA lessons during any week.

EXAMPLES OF PROCESS AOs

LOOKING AT GROUPS AND THE PROPERTIES OF THEIR MEMBERS (1)

(Remind the children about objects and events and their properties)

There are many different kinds of objects (and events) in the world around us.

There are many objects (and events) that people need ways to help them think about them and remember them.

One way that helps people think about objects (and events) and remember them is to put them into groups.

A group is a bunch of objects (or events) that are together because they are like in some way.

People usually have a reason for making groups. One important reason is that some of the objects (and events) have properties that are alike in some way.

Sometimes different people use different ways for grouping the same objects.

We may have to figure out the reasons they used for grouping the objects.

We have to look for the special property the other people used for grouping the objects (and events).

Sometimes different people agree to group the same objects in the same way.

They agree on one property shared by the objects.

Sometimes we look for objects that share one special property. We collect objects that share the one special property into a group. We do this because we think the property is very important. We have a reason for thinking the property is important.

STRATEGY FOR PUTTING OBJECTS AND EVENTS INTO A GROUP AND FOR SWITCHING CRITERIA (2)

(Remind the children that objects and events have properties that may be used to put them into groups)

Sometimes we may wish to place objects (and events) into special groups. We might want to do this because it makes it easier for us to think about the objects (and events). We might want to do this to help us remember how objects (and events) go together in special ways.

There is a special way we can use for putting objects (and events) into groups.

First, we must look at all the objects (and events).

We look to see what their properties are.

We look to see if some of the objects (and events) have properties that are alike in some way. If we find some objects that share a property, we can use that property for choosing objects.

We can collect together all the objects that share that property.

We must make sure we do not change from thinking about that first property we choose.

We must make sure to choose every object in the big group objects that has that property, and place all those objects together in a special group.

When we have finished making the first special group we may be able to make other special groups from the objects in the big group we have not yet used.

We first look to see what the properties of these objects (and events) are.

See if some of the objects (and events) have properties that are alike in some way.

If some of the objects (and events) share a property, we can put them together in a special group.

Remember that special property.

Make sure to collect together all the objects (and events) that share that property.

You see, we collected together the second special group just like we collected the first special group.

When we place objects (and events) together into special groups we can always use this way of collecting them together.

MAKING GROUPS BY USING ALL OF THE OBJECTS AND EVENTS (3)

Remember all the things we must do when we make groups.

We must look at all the objects (and events).

Look for their properties.

Then decide if either all or some of the objects (and events) have properties that are the same in some way.

If all the objects (and events) have a property that is the same in some way, we can put them all together to make one big group.

We choose a property that all of the objects (and events) share.

We then make a group out of all the objects.

When you have made one big group from all the objects (and events) you may be able to make other big groups from all the objects by choosing another property they all share.

Choose another property that is shared by all the objects (and events).

Put all the objects together that have that property.

Objects and events can have many properties. So we can have many reasons for putting all the objects together into a group.

This is the way we make collections with all the objects and events we have.

MAKING GROUPS BY USING SOME OF THE OBJECTS AND EVENTS (4)

Remember all the things we must do when we make groups.

We must look at all the objects (and events); look for their properties; decide if either all or some of the objects (and events) have properties that are the same in some way.

If only some of the objects (and events) have a property that is the same in some way, we can put those objects together to make a smaller group.

We choose a property that some of the objects and events share.

We then make a group out of those objects.

When we do this we use just some of all of the objects (and events) in the big group.

We may be able to make more than one small group in this way from all the objects (and events) in the big group.

Each time we make a small group we:

Choose a property shared by some of the objects and events in the big group.

Collect those objects together that share that property.

We then have made a small group from some of the objects in the big group.

This is the way we make small groups with some of the objects (and events) in big groups.

MULTIPLE CLASSIFICATION (SPECIAL CASE OF 2 GROUPS: DICHOTOMOUS SORTING (5)

(Remind the children that sometimes all the members in a group will share a property and sometimes only some will share a property)

Remember we said that when some of the objects (and events) in a large group have a property that is the same in some way, we can put those objects and events together to make a small group out of the bigger group.

Sometimes we want to make two small groups of objects (and events) from one big group of objects (and events).

We need to find two properties so that one small group of objects share one of the properties and another small group of objects share the other property.

We collect the objects that share one property we are thinking about.

Then we collect the remaining objects together which share the other property we are thinking about.

We have then placed all the objects into two small groups.

Sometimes one big group of objects and events may have a number of properties so that the big group can be made into two smaller groups in a number of different ways.

After we have made the big group into two smaller groups we can put them all back together again into the big group.

Then we can look for two different properties that are shared by two small groups of objects.

We can then again make two smaller groups from the big group.

These two groups will be different in some way from the first two groups we made.

We can go on making the big group of objects into two smaller groups in different ways for as many times as we can find different pairs of properties.

HIERARCHICAL GROUPING (6)

Remember how we made big groups using all the objects we had?

Remember how we made small groups using just some of the objects from the big group for each small group?

Sometimes all the objects we have can have a number of special properties which are the same in some way.

One of the properties will be shared by all the objects, so they can be collected into one big group.

Other properties will be shared by some of the objects in the big group, so we can also collect the objects into a number of small groups.

Because all the properties which belong to the objects are the same in some way all the small groups will be part of the big group.

Sometimes we can collect together some of the small groups to make a group. These small groups will share a special property.

Whatever number of groups we make out of the big group, they will always be part of the big group.

Although all the small groups we make will be the same in some way, they will also always be different to each other in some way.

MAKING HIERARCHICAL GROUPINGS (7)

Remember that objects can sometimes belong to both one big group and a number of small groups at the same time.

This is how we make groups that fit together in this special way:

1. Look at all the objects.

See if any are the same in some way (property).

Put all the objects together that go together because they are the same in some way. Is there a name for that big group of objects?

Keep remembering the name for that group of objects.

2. Look at the big group of objects. Look at all the objects.

See if some of them are the same in some way (property).

The property they share must be like the property all the objects share in some way.

Put these objects together.

Is there a name for that small group of objects?

Keep remembering the name for that small group of objects.

We call the small group we have made by that name.

The other small groups we make are collected together in the same way.

We must remember the name of the big group we have made.

We must remember the names of the small groups we have made.

We must remember that the small groups all fit together to make the big group.

The property each small group has is like the property the big group has in some way.

All the objects we have are part of a number of small groups and one

big group at the same time.

3. See if the rest of the objects from the big group can be made into small groups.

Look for properties some objects share.

Each property must be like the property all the objects share.

Make other small groups like you made the first small group.

(The rules at 1 and 2 may need repeating several times.)

Remember the names (properties) of all the small groups you make.

4. Sometimes you can collect some of the small groups together.

To do this they must have a property they share.

5. Make all the small groups into the big group you had at first.

Remember the name of the big group.

Remember the name of each of the small groups.

(How are the big groups and the small groups alike?

How are the small groups different from each other?)

6. Remember that all the objects you now have belong to both the one big group and the small groups at the same time.

There are always more objects in the one big group than any of the small groups on their own.

Sometimes we may wish to compare a big group of objects to one of its small groups of objects.

The small group of objects belong to that small group and the one big group at the same time.

There will always be more objects in the big group than in a small group which is part of the big group.

INTRODUCTORY AO LESSON: GENERAL IDEAS REGARDING SERIATION (1)

Remember that there are many objects in the world around us. People use special ways to help them think about and remember them. One of those special ways to think about and remember objects is to put them in a line next to each other so that they are in a special order.

When we put objects in an order next to each other they must have a property we can measure in some way.

Remember how we found properties of objects.

Remember what a property is.

When we measure a property we find out about:

how long or short it is;

how wide or narrow it is;

how high or low it is;

how fat or thin it is;

how heavy or light it is;

how loud or soft a noise it can make; etc.

These properties we can measure.

We need to do a number of things so we can put objects in an order next to each other.

First look at all the objects.

Look for a property that all the objects share and which we can measure.

Next, choose the object that has either the most amount of that property or the least amount of that property.

Put that object first in the line

*Look at all the objects that are left.

The one you choose next should have the closest amount of property to the one you chose before.

(Repeat this sequence of instructions from (*) on until completion of serial ordering.)

When we have finished placing all the objects into an order we should have a line of objects going from those with the most amount of property to the least, or from those with the least amount of property to the most amount of property.

Sometimes we want to change the order to our objects. If the order is going from the most amount of property to the least we might want to change the order so that the objects are placed in a line next to each other from those with the least amount of property to those with the most amount of property.

Sometimes we can make more than one order with the objects we have.

We can begin the order with the object that has the most amount of a property. We can begin the order with the object that has the least amount of a property.

Sometimes we want to add an object to an order. If we are going to do this we must find a place for the object in the order of objects we have made. We must find a place for the object we are going to add so that when it is placed in the order the object on one side of it has more amount of property than it has and, the object on the other side has less amount of property than it has.

(This arrangement is demonstrated by the teacher, attempted by the children, and practiced in subsequent learning activities.)

GENERAL SERIATION (2)

Part 1:

I'm going to tell you a story about three bears who lived in a house in the woods. Here are some objects that belong in the three bears' house and here are the three bears.

(The following materials are distributed randomly on a "flannel board": 3 bears, 3 bowls, 3 spoons, 3 chairs, and 3 beds of different sizes--small. medium, and large.)

I want to tell you the story but it is very hard for me to think about all of these objects when they are scattered all over the board like this (pointing). So before I start I want to show you a special way of putting objects into an order that I know about. This will make it easier for us to think about, and remember, all of these objects for our story. I will start with the bears. Let me find all of the bears and put them over here like this. (Transfer the bears to a second flannel board.) I don't want to think about these yet (the bowls, spoons, chairs and beds), so I'll leave them here (set aside). If I want to put these objects (the bears) into a special order, I need to do certain things. You can help me. First, we must look at all these objects. We must look for one certain property that all the objects share and that we can measure (together decide on the property size). Next, we must choose the object that has either the most amount of that property or the least amount of that property. We need to find either the biggest bear or the smallest bear (decide on one). We are going to put the bears in a special order next to each other. We are going to put each bear on this line on the flannel board. We put this bear (biggest or smallest) first on the line. Then we look at all the objects that

are left. The one we choose next should have the closest amount of property to the one we chose before. Which bear has the next closest size to this bear? That bear is the next biggest/smallest. He goes in line next to this one (placing in line). We need to do this until all the objects are in order. So this last bear goes here (placing in line). He has the very least/most amount of the property size. He is the biggest/smallest bear.

When we've finished placing all the objects into an order, we have a line of objects going from those with the most amount of the property we choose (size) to those with the least amount of property (size) or, the least amount to the most amount of property (size). Our line goes from the biggest bear to the smallest bear (or vice versa).

Part 2:

Sometimes we want to change the order of our line. Instead of starting with the one that we started with before (most or least) we can start with the other one. Last time we started with the (_____) bear, this time we can start with the (_____) bear. We make the order in the same way.

(Leave the first set of bears as ordered. Bring out a second set of bears to demonstrate the reversed order so that a comparison can be made.)

Sometimes we want to make more than one order with the objects we have. (Refer back to the board with the spoons, bowls, chairs, and beds.) If we are going to make more than one order we must make sure that all the ordered lines begin with the same amount of property (either the most or the least). If we have the bears in this order (from biggest to smallest or vice versa) we must have all the other ordered lines going from biggest to smallest. In that way the biggest bear gets the biggest chair, the biggest

bed, the biggest spoon and the biggest bowl; the smallest bear gets the smallest chair, the smallest bed, the smallest spoon and the smallest bowl.

Part 3:

Sometimes we want to add an object to an order. If we are going to do this we must find a place for it so that the objects on one side have more amount of property and the object on the other side has less amount of property. Here is Goldilocks (bring out Goldilocks). If we want to add her to the line of bears we must find a place where the bear on her one side is bigger and the bear on her other side is smaller than she is (demonstrate).

Now that I've shown you how to put things into order we need to set up the bears house so that everything is in an order. Then I will tell you the story of Goldilocks and the Three Bears.

Note: This initial, and most general AO lesson, is presented in perhaps three or four 15/20 minute sessions. All, or part of it, may need repeating until it is estimated children have reached criterion level of understanding. Further AO lessons deal, at a less abstract level, with additive seriation, one-to-one correspondence, and reversibility.

Related Activities--General Seriation

1. Give each child in the group their own set of 3 bears, chairs, beds, spoons, and bowls. (You can use a ditto sheet to make enough copies for each child.) Ask them to seriate each set of objects, reverse the order, form 1-1 correspondences and perform additive seriation with Goldilocks and her bowl, bed, chair, and spoon. At the end of this activity, the children could color in their objects and past them onto a large piece of paper.

2. With the help of the children, set up the socio-dramatic play area as the three bears house. (Include real beds, chairs, bowls, spoons, aprons, hats, shoes, etc. which can be seriated.) Designate roles and let the children act out the three bears story.

3. Make a game board where the children would move their markers to a space designated by the spin of the dial. If they land on a space containing a bear they have to choose an envelope containing a set of objects which must be seriated.

(These activities provide further practice on familiar materials.)

AO: ADDIVITE SERIATION--GENERAL

(Remind the children that objects can be put into certain special orders. The orders can be reversed and a 1-1 correspondence can be set up with different sets of objects.)

Remember when we put objects into an order according to a special property that they have.

We sometimes want to add other objects into the line so they fit into the order that has been made.

When we add objects into an order we must remember to do several things.

First, we must look at the objects that are already in an order. Remember the property that was used to put them into that order.

We must put the object that we want to add into the order in the line so the object on one side has more of that property and the object on the other side has less of that property.

We place the object we are fitting into the line between these two objects.

If the object you wish to add has either the most amount of the property or the least amount of the property it should be either at the beginning or end of the line.

If the object we wish to add does not have either the most or least amount of property then we must compare it to all the other objects until we've found a place in line where the object on one side has more of that property and the object on the other side has less of that property.

AO: SERIATION--1-1 CORRESPONDENCE (3)

Remember that we have been looking at objects which have different amounts of a certain property.

We know that we can put objects into an order according to their different amounts of that certain property.

Sometimes we placed objects in line from the object with the least amount of property to the object with the most amount of property.

Sometimes objects were placed in a line from the objects with the most amount of property to the least amount of property.

Sometimes we want to change the order so they are going the other way.

The groups we've been looking at have only had one object that each had a certain amount of property.

When more than one object in a group has the same amount of a property, we can make more than one group or order.

When we put these objects into their orders, we must make sure that for every object we place in one line, we place an object that has the same amount of that property in another line.

When we've done this, every object in one group or line will have an object(s) in the other group(s) which has the same amount of a special property.

If we want to make more than one order, we must remember to do certain things.

First, make a group of objects that are the same in some way, with each object having a different amount of some measurable property.

Put these into an order, starting with either the least or the most amount of a property.

Next, find another group of objects that is the same in some way (or may be just like the first group of objects), with each object having a different amount of some property.

Put these objects into an order either directly above, below, or beside the first ordered group.

Be careful that you keep your orders the same.

If you start with the object with the least in the first group, you must start with the object with the least in your other groups.

Remember that for every object in one ordered group there should be an object in the other group(s) that is the same in some way.

AO: SERIAL ORDERING OF OBJECTS BY WEIGHT (4)

(Remind the children that objects can be put into an order next to each other in a line so they can be measured in some special way.)

Sometimes we have objects which have different weights.

We may want to put these objects into a line next to each other so that it will be easier to measure the order of their weights.

If we want to put objects into an order according to their weights, we must do certain things.

First measure the weight of each object, some are heavier than others or lighter than others.

Choose either the heaviest object or the lightest object.

Put that object first in the line.

Weigh all the objects that are left.

If you've chosen the heaviest object first, the one you choose next should be the next lightest in weight. This object will be the heaviest of the ones you have left.

Put that one in line next to the one you've chosen just before.

Continue placing objects next to each other until all the objects are in order from heaviest to lightest.

If you've chosen the lightest object first, the one you choose next should be the next heaviest in weight. This object will be the heaviest of the ones you have left.

Put that one in line next to the one you've chosen just before.

Continue placing objects next to each other until all the objects are in order from: heaviest to lightest/lightest to heaviest.

AO: SERIAL ORDERING OF OBJECTS BY SOUND (5)

(Remind the children that objects can be put into an order next to each other in a line so they can be measured in some special way.)

Sometimes we have objects which have different sounds.

We may want to put these objects into a line next to each other so that it will be easier to measure the order of their sounds.

If we want to put objects into an order according to their sounds we must do certain things.

First listen to the sound of each object, some sounds are higher than others or lower than others. Some sounds are louder than others or softer than others. Choose the object that has either the highest or lowest or loudest or softest sound.

Put that object first in the line.

Listen to all the sounds of the objects that are left.

If you've chosen the object with the highest sound first, the one you choose next should be the one with the next lowest sound.

Put that one in line next to the one you've chosen just before.

Continue placing objects next to each other until all the objects are in order from those with the highest sound to those with the lowest sound.

If you've chosen the object with the lowest sound first, the one you choose next should be the one with the next highest sound.

Put that one in line next to the one you've chosen just before.

Continue placing objects next to each other until the objects are in order from those with the lowest sound to those with the highest sound.

If you've chosen the object with the loudest sound first, the one you choose next should be the one with the next softest sound.

Put that one in line next to the one you've chosen just before.

Continue placing objects next to each other until all the objects are in order from those with the loudest sound to those with the softest sound.

If you've chosen the object with the softest sound first, the one you choose next should be the one with the next loudest sound.

Put that one in line next to the one you've chosen just before.

Continue placing objects next to each other until all the objects are in order from those with the softest sound to those with the loudest sound.

AO: SERIAL ORDERING OF OBJECTS BY COLOR (6)

(Remind the children that objects can be put into an order next to each other in a line so they can be measured in some special way.)

Sometimes we have objects which have the same color but have different darknesses and lightnesses of that color.

We may want to put these objects into a line next to each other so that it will be easier to measure the order of their darkness or lightness of color.

If we want to put objects into an order according to their darkness or lightness of color we must do certain things.

First look at the darkness and lightness of color that each object has, some are darker than others or lighter than others.

Choose either the darkest colored object or the lightest colored object.

Put that object first in the line.

Look at all the objects that are left.

If you choose the darkest colored object first, the one you choose next should be the next lightest. This object will be the darkest color of the ones you have left.

Put that one in line next to the one you have chosen just before.

Continue placing objects next to each other until all the objects are in order from darkest to lightest.

If you choose the lightest colored object first, the one you choose next should be the next darkest. This object will be the lightest color of the ones you have left.

Put that one in line next to the one you've chosen just before.

Continue placing objects next to each other until all the objects are in order from lightest to darkest.

EXAMPLES OF CONTENT AOs IN THE

SCIENCE CURRICULUM

LIVING AND NON-LIVING (1)

All the things around us are either living or non-living.

We can tell if something is living or non-living in many ways.

Living things can move by themselves. Non-living things can not move by themselves; they need help.

All living things must have food and water to eat and drink. If a living thing does not get food and water to eat and drink it will die. Non-living things do not need food and water. If a non-living thing does not get food and water it does not matter because it does not need food and water.

All living things make new ones of their own kind. Living things are born, live for awhile, then die. Non-living things can not make new ones of their own kind.

All living things grow bigger and older. Non-living things can grow older but they do not grow bigger.

All living things need air to breathe. If they do not get air to breathe, then they will die. Non-living things do not need to breath air.

PLANTS AND ANIMALS (2)

Remember when we talked about living and non-living things. Living things move by themselves, need food and water, make new ones of their own kind, grow older and bigger, and breathe air. Non-living things do not move by themselves, do not need food and water, do not make new ones of their own kind, do not grow bigger, and do not breathe air.

Living things are either plants or animals. There are many different sorts of plants (examples). There are many different sorts of animals (examples).

We know that plants and animals are alike because they can both move by themselves (plants move their leaves to the light; animals walk, crawl, slither, jump, etc.). They are also different from one another because plants are not able to move themselves from place to place. Plants can not decide for themselves where they want to travel. Sometimes plants move with the help of other living and non-living things but they cannot think about where it is they want to go and then go there. Animals can move from one place to another when they want to.

We know that plants and animals are alike because they both need food and water to eat and drink. But they are different in the ways they get the food and water, and where they get it from. Plants get food and water from the ground or dirt, which they take in through their roots. Animals must move from place to place to gather or hunt for their food and water. They take the food and water in through their mouths.

We know that plants and animals are alike because they can make new ones of their own kind, but they are different in the ways they do this. Plants can make new ones of their own kind through seeds, leaf cuttings,

root division or spores. Animals can make new ones of their own kind through eggs. Sometimes the mother animal lays the eggs and the baby hatches outside of the mothers body. Sometimes the eggs hatch while they are still inside the mothers body. Then they are born alive.

We know that plants and animals are alike because they all grow older and bigger, but they grow in different ways. Plants grow taller and wider and are always growing new parts. Animals grow taller and wider but they do not grow new parts for their bodies.

We know that plants and animals are alike because they both need to breathe air, but they breathe air in different ways. Plants use their leaves to take in and breathe the air. Animals use their noses and mouthes to take in the air which goes to a special part of the body which breathes the air.

ANIMALS (3)

Remember we said that if something is a living thing it must be either a plant or an animal.

There are two main groups of animals. One group is called simple animals, and the other group is called complex animals. Simple animals do not have very many body parts. Complex animals do have many body parts. They have parts for eating, parts for breathing, parts that carry and hold blood in their bodies, parts that move them from place to place, and parts that are used to make new ones of their own kind. Simple animals do not have all of these parts.

There are many different kinds of simple animals (examples of protoza, sponges, corrals, worms, etc.). There are many different kinds of complex animals (examples of mammals, fish, birds, reptiles, amphibians, insects, etc.).

We will be talking mainly about complex animals because they are the ones we know best.

APPENDIX B

DESCRIPTIONS OF TASKS USED FOR PRETESTS, POSTTESTS, DELAYED POSTTESTS, AND INTERIM-TESTS AND TYPES OF JUSTIFICATION RESPONSE IN CONSERVATION TASKS

Classification

Dichotomous Sorting

WARM UP

E randomly places all blocks before S and says, "Here are some blocks for us to work with. Tell me what you see. (Tell me about them)."

If S does not spontaneously say, "red," "blue," "circle," "square," "big," "little," E picks up two blocks for contrast and asks S "How are these different?" or "What's different about these?"

If S does not respond to these questions, E continues to probe for understanding of attributes holding up blocks and asking questions such as:

1. "Are these the same size (color, shape)?" "Which one is bigger?"
2. "Is this one just as big as this one?" "Which one is bigger?"
3. "This one is big; show me one that is just as big."

E continues until S has correctly verbalized or matched all the attributes.

To conclude the warm up E says, "Good, you've told me (shown me) there are square blocks and circle blocks, blue blocks, and red blocks, big blocks and little blocks.

FIRST SORT

Sorting Instructions

E mixes all the blocks, puts two boxes in front of S (one on either side of the blocks), and says, "Now I want you to put (divide) these blocks into two bunches--put one kind in this box and one kind in this box." If

S puts only one block in each box, E says, "Put all the blocks into the boxes the way they go together." or "Put one bunch in this box and one bunch in this one."

Directions may be repeated three or four times, but S should not be pushed.

E makes sure that S is finished before asking for a justification.

Justification

E compliments the S's work saying, "Good ____, (name), you've really been thinking about where to put these blocks." or "That's an interesting way to sort the blocks." E then inquires, "How did you know (decide) to put them together like this?" "Can you tell me why all these (pointing) go together?" or "I wonder how you decided on that."

End the session if:

1. S has not responded.

Go on to the second sort if:

1. S has made a response of any kind.

SECOND SORT

Sorting Instructions

The blocks are again mixed and E says, "Last time you separated the two ____ (colors, shapes, sizes). (Omit this sentence if S has not made a dichotomy.) This time make two bunches in another way. Put one kind in here and one kind in here. Remember, do it in a different way, a new way."

Directions may be repeated. E makes sure S is finished before asking for a justification.

Justification

E compliments S's work saying, "Good _____, (name), you've really been thinking about where to put these blocks." or "That's an interesting way to sort the blocks. E then inquires, "How did you know (decide) to put them together like this?" "Can you tell me why all these (pointing) go together?" or "I wonder how you decided on that."

End the session if:

1. S does not respond.

Use demonstration dolls if:

1. S has repeated his first sort.

Go on to the third sort if:

1. S has made two different sorts.

DEMONSTRATION--SHIFTING CRITERIA

Use if the second sort was exactly the same as the first sort.

Materials: 6 paper dolls: 3 boys - 2 holding a flower
1 not

3 girls - 1 holding a flower
2 not

2 boxes

Procedure:

E says, "Look what I have now--some boy dolls and some girl dolls (points to each). Some have flowers, see (indicates those), and some don't. Now, put all the boys in this box (E helps S if he needs it) and all the girls in this box." When S has finished E compliments him saying, "Good _____, (name), you put all the boys in this box and all the girls in this box. Now, make two bunches in a new say. Put all the children that have flowers in this box, and all the children that don't have flowers in this

box."

THIRD SORT

Sorting Instructions

The blocks are again mixed and E says, "This time make two bunches in even another way. Remember, the first time you separated the _____ (colors, shapes, sizes). Then you separated the _____ (colors, shapes, sizes). This time do it in even a different way. Remember, to do it in a new way.

Directions may be repeated, but S should not be pushed.

E makes sure S is finished before asking for a justification.

Justification

E compliments S's work saying "Good _____ (name), you've really been thinking about where to put these blocks." or "That's an interesting way to sort the blocks." E then inquires, "How did you know (decide) to put them together like this?" "Can you tell me why all these (pointing) go together?" or "I wonder how you decided on that."

End the session if:

1. S has not made any of the dichotomies.
2. S has made only one dichotomy, but this was not the first time he made it.
3. S has made the three different dichotomies.

Go on the the fourth sort if:

1. S has just made his first dichotomy.
2. S has made two of the three dichotomies.

FOURTH SORT

Sorting Instructions

The blocks are again mixed and E says, "This time make two bunches in

even another way. Remember, the first time you separated the _____ (colors, shapes, sizes). Then you separated the _____ (colors, shapes, sizes). This time do it in even a different way. Remember, to do it in a new way.

Directions may be repeated, but S should not be pushed.

E makes sure S is finished before asking for a justification.

Justification

E compliments S's work saying "Good _____, (name), you've really been thinking about where to put these blocks." or "That's an interesting way to sort the blocks." E then inquires, "How did you know (decide) to put them together like this?" "Can you tell me why all these (pointing) go together?" or "I wonder how you decided on that."

End of Session*

*Exception: If S just made a second dichotomy, go on to a fifth sort (repeat procedures for the fourth sort).

SCORING CRITERIA

Dichotomies made in free situation are accepted.

Patterns are okay if a dichotomy is made.

Subgroups within a perfect dichotomy are okay.

Imperfect initial dichotomy is okay if corrected by S when asked for justification.

Relevant justification--anything that corresponds to reality and implies the criterion.

Name _____
Date _____
School _____
Tester _____
Time _____

FIRST SORT

Product:

1. No dichotomy

   a. Graphic sort (describe)

      1. no obvious pattern

      2. makes a "picture"--no consistent arrangement of size, shape, and/or color

      3. obvious pattern (geometric design)

      ____blocks not used (number)

   b. Non-exhaustive sort

      1. ____blocks not sorted (which?)

      2. all blocks sorted but ____ mistakes made (describe)

   c. Makes small groupings but fails to dichotomize the groups according to a set criterion

   d. Equivalent sort

   e. Other (describe) _____

2. Dichotomous sort

Criterion: (for 1b, 1c, 2).

   a. size

   b. shape

   c. color

   d. other _____

Justification: (Indicate appropriate comments made while S is working as well as those made in response to justification request)

1. No justification

2. Irrelevant justification _____

_____

3. Relevant justification _____

_____

SECOND SORT

Product:

1. No dichotomy

   a. Graphic sort (describe)

      1. no obvious pattern

      2. makes a "picture"--no consistent arrangement of size, shape, and/or color

      3. obvious pattern (geometric design)

      ____blocks not used (number)

   b. Non-exhaustive sort

      1. _____ blocks not sorted (which?)

      2. all blocks sorted but ____ mistakes made (describe)

   c. Makes small groupings, but fails to dichotomize the groups according to a set criterion

   d. Equivalent sort

   e. Other (describe) _____

2. Dichotomous sort

Criterion (for 1b, 1c, 2)

   a. size

   b. shape

   c. color

   d. other _____

Justification: (Indicate appropriate comments made while S is working as well as those made in response to justification request)

1. No justification
2. Irrelevant justification _____

_____

3. Relevant justification _____

_____

Demonstration dolls used?

Yes _____ No _____

THIRD SORT

Product:

1. No dichotomy
   a. Graphic sort (describe)
      1. no obvious pattern
      2. makes a "picture"--no consistent arrangement of size, shape, and/or color
      3. obvious pattern (geometric design)

      ____blocks not used
   b. Non-exhaustive sort
      1. _____ blocks not sorted (which?)
      2. all blocks sorted but ____ mistakes made (describe)
   c. Makes small groupings but fails to dichotomize the groups according to a set criterion
   d. Equivalent sort
   e. Other (describe) _____
2. Dichotomous sort

Criterion: (for 1b, 1c, 2)

a. size

b. shape

c. color

d. other _____

Justification: (Indicate appropriate comments made while S is working as well as those made in response to justification request)

1. No justification

2. Irrelevant justification _____

_____

3. Relevant justification _____

_____

FOURTH SORT

Product:

1. No dichotomy

   a. Graphic sort (describe)

      1. no obvious pattern

      2. makes a "picture"--no consistent arrangement of size, shape, and/or color

      3. obvious pattern (geometric design)

      ___blocks not used (number)

   b. Non-exhaustive sort

      1. _____ blocks not sorted (which?)

      2. all blocks sorted but _____ mistakes made (describe)

   c. Makes small groupings but fails to dichotomize the groups according to a set criterion

   d. Equivalent sort (equal number of blocks in each box)

   e. Other (describe) _____

2. Dichotomous sort

Criterion: (for 1b, 1c, 2)

a. size

b. shape

c. color

d. other _____

Justification: (Indicate appropriate comments made while S is working as well as those made in response to justification request)

1. No justification

2. Irrelevant justification _____

_____

3. Relevant justification _____

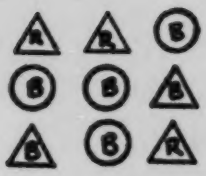
_____

CLASS INCLUSION

SOME ALL

Materials: Picture showing: 5 triangles - 3 red, 2 blue

4 circles - all blue



E discusses with S the shapes and colors and then asks:

1) Look at all the red figures; are all the red figures triangles?

Yes _____ No _____ Other _____

2) Look at all the triangles; are all the triangles red?

Yes _____ No _____ Other _____

3) Look at all the circles; are all the circles blue?

Yes _____ No _____ Other _____

4) Look at all the blue figures; are all the blue figures circles?

Yes _____ No _____ Other _____

CLASS INCLUSION (A)

Materials: 5 boy paper dolls - 15 cm. tall

3 girl paper dolls - 15 cm. tall

2 adult female paper dolls - 20 cm. tall

TWO SUBGROUPS

E shows S all the paper dolls and explains, "Here are some paper dolls. They're all people, but some are children and some are grown-ups (mommies). All the mommies are going to work for a while and the children all stay here to play (E removes the mommies). Let's see how many children we have. First you take all the boys over here. Count all of those boys." If S does not begin quickly to count alone, or counts incorrectly, E says, "Let's count them together" and helps S count. When S has finished counting, E repeats, "That's right, there are five boys. Following this procedure, E asks S to put all the girls right next to the boys. "Count all the girls." "Now all the children are together, aren't they. Count all the children." When the task is completed E mixes the dolls, and asks the following questions:

1. Are there more boys or more children?

   a. Response: _____

   b. Justification (1):

      i. "Which are the _____?" (group child says has more) — circle one: correct / incorrect

      ii. "Which are the _____?" (other group) — correct / incorrect

   c. *Justification (2): "How can you tell?" or "How did you know that?"

_____

*If child gives the number in each group as his/her justification, E asks, "Okay, you've told me how many there are. How do you know there are more _____?"

2. Are there more children or more boys?

   a. Response: _____

   b. *Justification (2): "How can you tell?" or "How did you know that?"

   _____

CLASS INCLUSION (A)

THREE SUBGROUPS

E brings back the mommies and says, "Now the mommies are home from work. Help me count the mommies. That's right, two mommies for all these boys and girls. Do you remember how many boys there are?" E helps S count unless S recalls the number. E says, "How about the girls; how many are there?" Again, E helps S count, if necessary. E says, "Now let's count all the people. Remember, we have to count the children and the mommies." E helps S if necessary. E asks:

1. "Are there more boys or more people?"

   a. Response _____

   b. Justification (1):

      circle one:

      i. "Which are the _____?" (the group the child said had more) correct incorrect

      ii. "Which are the _____?" (other group) correct incorrect

   c. *Justification (2): "How can you tell?" or "How did you know that?"

   _____

2. "Are there more people or more children?"

   a. Response _____

   b. Justification (1):

_____

*If child gives the number in each group as his/her justification, E asks "Okay, you've told me how many there are. How do you know there are more _____?"

circle one:

i. "Which are the _____?" (group child said had more) correct incorrect

ii. "Which are the _____?" (other group) correct incorrect

c. *Justification (2): "How can you tell?" or "How did you know that?"

_____

3. "Are there more people or more boys?"

a. Response _____

b. *Justification (2): "How can you tell?" or "How did you know that?"

_____

4. "Are there more children or more people?"

a. Response _____

b. *Justification (2): "How can you tell?" or "How did you know that?"

_____

CLASS INCLUSION (B)

Materials: 8 yellow blobs: 5 with holes
3 without holes
2 green blobs (without holes)

All are of equal size (approximately 10 cm. high).
Holes are 3 cm. in diameter

TWO SUBGROUPS

E puts out all the blobs and says, "We've got lots of blobs (shapes) for this game--yellow ones and green ones. We don't need the green ones for awhile so I'll put them away. Let's find out how many yellow blobs

_____

*If child gives the number in each group as his/her justification, E asks "Okay, you've told me how many there are. How do you know there are more _____?"

there are with holes in them." E helps S pick out all the ones with holes and together they count them. E asks how many yellow ones there are without holes and helps S count. E says, "Now let's count all the yellow blobs (the ones that have holes and the ones that don't have holes)." E then mixes the blobs and asks the following questions:

1. Are there more yellow blobs with holes or more of all the yellow blobs?

   a. Response _____

   b. Justification (1):

      circle one:

      i. "Which are the _____?" (the group the child said had more) correct incorrect

      ii. "Which are the _____?" (other group) correct incorrect

   c. *Justification (2): "How can you tell?" or "How did you know that?"

      _____

2. Are there more yellow blobs or more yellow ones with holes?

   a. Response: _____

   b. *Justification (2): "How can you tell?" or "How did you know that?"

      _____

CLASS INCLUSION (B)

THREE SUBGROUPS

E brings back the green blobs and says, "Here are the other blobs--two green ones. Now we've got lots of blobs to count--green ones and yellow ones. Remember how many yellow ones there were?" E helps S recall

*If child gives the number in each group as his/her justification, E asks, "Okay, you've told me how many there are. How do you know there are more _____?"

the number of yellow blobs, yellow blobs with holes, and yellow blobs without holes. If necessary E and S redivide the blobs and recount. E says, "Now let's count all the blobs (shapes). Remember we have to count the yellow ones and the green ones all together." E helps S if necessary.

E asks:

1. Are there more of all the blobs or more yellow ones?

   a. Response: _____

   b. Justification (1):

      circle one:

      i. "Which are the _____?" (the group the child said had more) correct incorrect

      ii. "Which are the _____?" (other group) correct incorrect

   c. *Justification (2): "How can you tell?" or "How did you know that?"

      _____

2. Are there more yellow blobs with holes or more of all the blobs?

   a. Response: _____

   b. Justification (1):

      circle one:

      i. "Which are the _____?" (the group the child said had more correct incorrect

      ii. "Which are the _____?" (other group) correct incorrect

   c. *Justification (2): "How can you tell?" or "How did you know that?"

3. Are there more of all the blobs or more yellow ones with holes?

   a. Response: _____

   b. *Justification (2): "How can you tell?" or "How did you know that?"

      _____

*If child gives the number in each group as his/her justification, E asks, "Okay, you've told me how many there are. How do you know there are more _____?"

EXPERIMENTER'S MANUAL

FOR MATRIX TASKS

by

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MATRIX TASKS

MATRICES

Materials: 9 blue cylinders keyed with the following abbreviations:

S = skinny	1 = short
M = medium width	2 = medium height
F = fat	3 = tall

3 x 3 section wooden board

Procedure:

E places the nine blocks in a random fashion on the table next to the matrix board and says, "Tell me what you see here."

(a) If S does not mention the differing heights, E points out M3 and M1 and asks, "How are these two blocks different?" If S refers only to the size difference (for instance, "One is big and one is little"), E says, "That's right, one is tall and one is short."

(b) If S does not mention the differing widths, E points out S2 and F2 and asks, "How are these two blocks different?" If S refers only to the size difference (for instance, "One is big and one is little"), E says, "That's right, one is skinny and one is fat."

E then says, "Now I am going to put the blocks on this board in a special way." E unsystematically[1] places the blocks as in Figure 1.

Figure 1

S

	(col.1)	(col.2)	(col.3)
(row 1)	M3	S3	F3
(row 2)	M1	S1	F1
(row 3)	M2	S2	F2

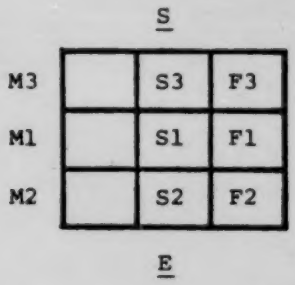
E

[1] This means neither by row nor by column. Instead something like: first S3, then M2, then F3, etc.

E says, "Look very carefully at how the blocks go. They make a pattern. Look carefully to see the pattern."

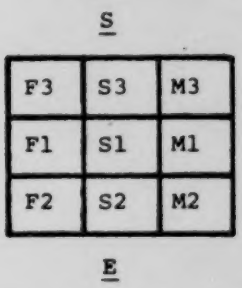
After 15 seconds, E removes blocks in Column 1 (M3, M1, M2) and places each block off the board next to its square as in Figure 2.

Figure 2



E moves blocks from Column 3 (F3, F1, F2) to Column 1, then places M3, M1, and M2 in Column 3 so that matrix looks like Figure 3.

Figure 3



E says, "Look carefully at how the blocks now go. They make a pattern now, too. Look carefully to see the pattern."

After 15 seconds, E removes blocks in Row 3 (F2, S2, M2) and places each block off the board next to its square as in Figure 4.

Figure 4

S

F3	S3	M3
F1	S1	M1

F2 S2 M2

E

E moves blocks from Row 1 (F3, S3, M3) to Row 3, then places F2, S2, and M2 in Row 1 so that matrix looks like Figure 5.

Figure 5

S

	(col.1)	(col.2)	(col.3)
(row 1)	F2	S2	M2
(row 2)	F1	S1	M1
(row 3)	F3	S3	M3

E

E says, "Look carefully again at how the blocks go. They make a pattern this way, too. Look carefully to see the pattern."

After 15 seconds, E says, "Now I am going to take away one block and then ask you to put it back so that the board looks the same as it does right now." E removes F2, puts it on the table as in Figure 6.

Figure 6

S F2

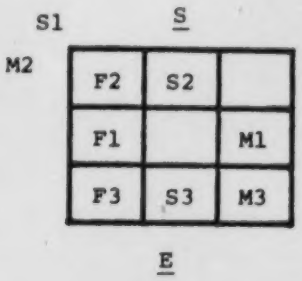
	S2	M2
F1	S1	M1
F3	S3	M3

E

E says, "Please put this block (E pointing to F2) back where it belongs." E records S's response on scoresheet. If S does not correctly replace F2, E places it back in position.

Next, E says, "Now I am going to take away two blocks and then ask you to put them back so that the board looks the same as it does right now." E removes M2 and S1, and places them as in Figure 7.

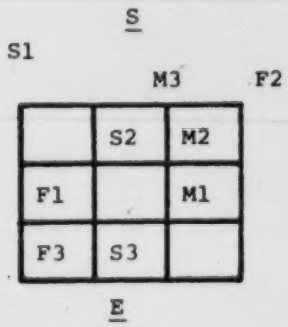
Figure 7



E says, "Please put these blocks (E pointing to M2 and S1) back where they belong." E records S's response on scoresheet. If S does not correctly replace two blocks, E places them back in position.

Then, E says, "This time I am going to take away three blocks and then ask you to put them back so that the board looks the same as it does right now." E removes S1, F2, and M3 and puts them on table as in Figure 8.

Figure 8

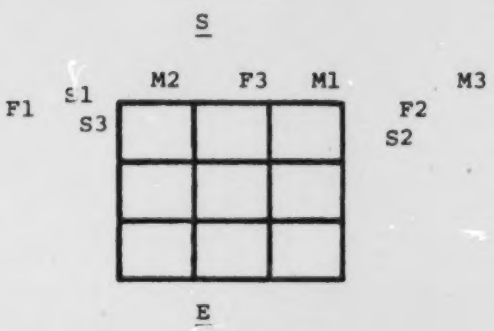


E says, "Please put these blocks (E pointing to S1, M3, and F2) back where they belong." E records S's response on scoresheet. If S does not correctly replace three blocks, E places them back in position.

Next, E says, "This time I am going to take all the blocks off the board. Then I am going to put one back, but it will be in a different place than it is now. After that I will ask you to put the blocks back so that they make a pattern like this one. Now look at the board very carefully so that you can remember the pattern."

After 15 seconds, E removes all the blocks from the board in an unsystematic fashion and places them as in Figure 9.

Figure 9



If S is assigned presentation order (1), E places F3 in center position as in Figure 10-1. If S is assigned presentation order (2), E places M2 in center position as in Figure 10-2.

Figure 10-1

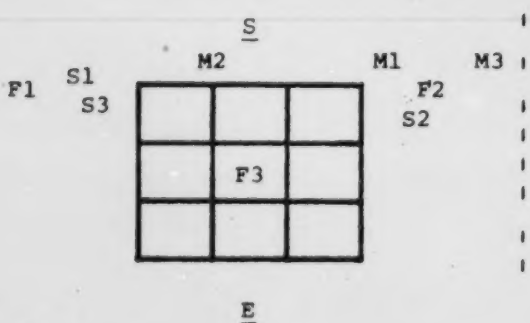
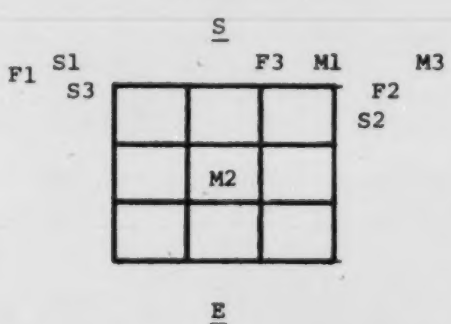


Figure 10-2



Then E says, "Please put the blocks back on the board so that they make a pattern like they did before. Remember, do not remove this block (E pointing to block in center). It must stay right where it is." If S attempts to lift center block, she/he is reminded that it is to stay in its place. E records S's response on scoresheet.

When S is finished, E assures S that he/she did very well.

E removes all blocks from board and places them as in Figure 11 below (note: same as Figure 5).

Figure 11

S

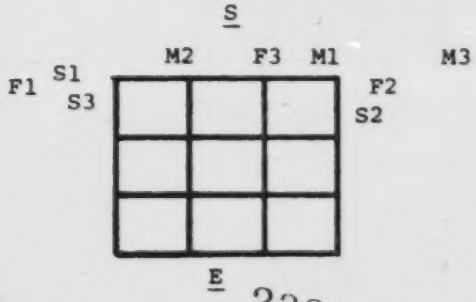
F2	S2	M2
F1	S1	M1
F3	S3	M3

E

E says, "This time I am going to take all the blocks off the board. Then I am going to put one back, but it will be in a different place than it is now. After that I will ask you to put the blocks back so that they make a pattern like this one. Now look at the board very carefully so that you can remember the pattern."

After 15 seconds, E removes all the blocks from the board in an unsystematic fashion and places them as in Figure 12 (note: same as Figure 9).

Figure 12



If S is assigned presentation order (1), E places M2 in center position as in Figure 13-1. If S is assigned presentation order (2), E places F3 in center position as in Figure 13-2.

Figure 13-1

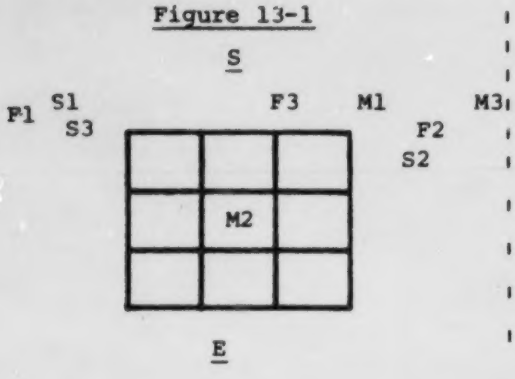
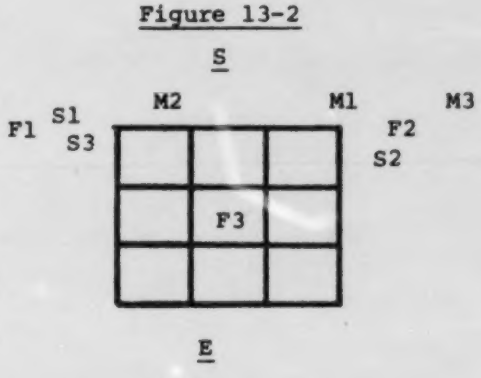


Figure 13-2



Then E says, "Please put the blocks back on the board so that they make a pattern like they did before. Remember, do not remove this block (E pointing to block in center). It must stay right where it is." If S attempts to lift center block, he/she is reminded that it is to stay in its place. E records S's response on scoresheet.

When S is finished, E assures S that she/he did very well.

General

S is always reassured about her/his performance whether she/he replaces all the objects correctly or not. If at any time S replaces the blocks incorrectly, the blocks are placed correctly by E before proceeding to the next task. However, when this happens E reassures S that he/she is doing well and explains that E is arranging the blocks for the next game. After the warm-up (i.e., after end of Page 3 of instructions), E never mentions the height or width of any of the blocks.

SCORESHEET FOR S's

Assigned Presentation Order (1)

NAME _____

GRADE _____

SCHOOL _____

DATE _____

TESTER _____

[E records S's actual placement(s)]

Figure 6

S

	S2	M2
F1	S1	M1
F3	S3	M3

E

Figure 7

S

F2	S2	
F1		M1
F3	S3	M3

E

Figure 8

S

	S2	M2
F1		M1
F3	S3	

E

Figure 10-1

S

	F3	

E

Figure 13-1

S

	M2	

E

MATRIX TASKS

SCORESHEET FOR S's

Assigned Presentation Order (2)

NAME _____

GRADE _____

SCHOOL _____

DATE _____

TESTER _____

[E records S's actual placement(s)]

Figure 6

S

	S2	M2
F1	S1	M1
F3	S3	M3

E

Figure 7

S

F2	S2	
F1		M1
F3	S3	M3

E

Figure 8

S

	S2	M2
F1		M1
F3	S3	

E

Figure 10-2

S

	M2	

E

Figure 13-2

S

	F3	

E

TRANSITIVITY

WARM UP

E shows the child a picture of two perceptibly unequal parallel lines (10 cm and 20 cm, respectively) and asks,

"Are the two lines the same length?"

* Yes No No Response

"Which line is longer?"

* Correct Incorrect No Response

"Which line is shorter?"

* Correct Incorrect No Response

TASK

Materials: 28.5 cm green stick, 27.5 cm green stick, 27.5 cm yellow stick

Instructions:

E shows the child each of the three sticks (individually) to be used in the game and then places them to the side. E then places the short green stick and the yellow stick close together on the table (vertically, to E's right) so the child can observe that they are of equal length. E has the child verbalize that they are the same length. (E may stand the sticks on end to demonstrate the similarity in length.) E leaves the short green stick in place and places the long green stick to E's left, 15 inches from the short green stick and next to the yellow stick so the child can observe that the yellow stick is the shorter of the two. E has the child verbalize this fact. E reminds the child not to touch the sticks. E removes the yellow stick, leaving the two green sticks in place. E asks the following (randomly ordered) questions concerning the two green sticks:

_____Are these two sticks the same length?

* Yes No No Response

_____Is one of the sticks longer? (If "yes," E asks which one is longer?)

* Yes: short long No No Response

_____Is one of the stick shorter? (If "yes," which one is shorter?)

* Yes: short long No No Response

RELATIONS

Serial Ordering

Materials: 7 apples (with dark stems) varying in size (diam.: 2.5, 3.5, 4.5, 5.5, 6.5, 7.5, and 8.5 cm)

Preparation:

E puts out the 3 largest apples in a random, non-linear arrangement and asks:

"Where is an apple that is bigger than this one?" (E points to the middle sized apple)

"Where is an apple that is smaller* than this one?" (E points to the middle sized apple again)

"Now we want to arrange these apples so that if we're very, very hungry we can find the biggest one quickly. If we aren't very hungry at all, then we want to find the smallest apple. Let's put these apples so that they go from biggest to smallest. See, here's the biggest one. Put it here. Put the next biggest one here. And the smallest apple here."

(If S doesn't pick the appropriate apple, E can prompt self-correction.)

*"Little" can be used in addition to or instead of "small" throughout.

Task:

E then places seven of the seriated apples on the table (in random, non-linear arrangement)

Explanation:

E explains, "Now we have lots of apples. Put these apples in a row so they go from biggest to smallest, just like we did before." If S hesitates, E asks S to find the biggest apple. "Now put all the other apples so they go from biggest to smallest. E can indicate with a gesture what is meant

by a "row" (e.g., using edge of table, etc.).

1. Help required: Yes_____ No_____

2. Indicate order in which S arranges the apples _____
_____

3. Number the apples S places correctly alone. (If help is needed placing the largest one, the maximum score is 6):

0 1 2 3 4 5 6 7 (circle the number)

RELATIONS

Additive Seriation

Materials: 10 apples of increasing size (same size as the 7 apples from successive comparisons and 3 more: 9.5, 10.5, and 11.5 cm in diameter)

Preparation:

E lines up a small (2) and a large (7) apple on the table (close together so that they will have to be moved apart to make room for the middle sized one). A middle sized one is given to the S (placed near S). E says, "We want to arrange these apples to that we can eat the smallest one first and save the biggest one for last. Where does this apple go?" (indicates middle size)

Correct_____

Incorrect_____

If incorrect, E explains that the apple has to go in between so it has a smaller apple on one side and a bigger apple on the other. E puts out 7 apples (numbers 1, 3, 4, 6, 8, 9, 10) and says, "Now we have lots of apples to eat. Let's line them up with the smallest one here so they get bigger and bigger. E places 7 apples in sequence with the smallest

to the S's left and with equal spaces between apples.

Explanation:

E places apples number 2, 5, 7 (randomly arranged) near S and says, "Oh, there are three more apples for us to eat. You put them with the other apples so that the apples go from biggest to smallest. Each apple must go in so that there is a smaller apple on one side and a bigger one on the other, just like our other row of apples." If S fails to get the idea, E places one of the apples for him, moving the apples apart, if necessary, to make space. After S has finished, E asks, "Have you got them all the way you want them? Check and make sure."

1. Help necessary: Yes _____ No _____
2. Final arrangement of apples. (Indicate number of apples and position where placed) (1___3___4___6___8___9___10___)
3. Number of apples S (above) places correctly: 0 1 2 3 (circle the number)

RELATIONS

Serial Correspondence

Materials: 7 apples (with dark stems) increasing in size (2.5, 3.5, 4.5, 5.5, 6.5, 7.5, 8.5 cm)

7 worms increasing in size (4, 6, 8, 10, 12, 14, 16 cm long)

Preparation:

E places the apples in a seriated row on the table (smallest to S's left). E then presents the S with the worms in a mixed array and talks about the materials and the seriation of the worms (e.g., "Some worms are bigger than others just like some apples are bigger than others. They'll have to line up too").

Explanation:

E explains, "These apples are lined up in order from the biggest one to the smallest one (gesture). Now you line up the worms in order from the biggest one to the smallest one so that each one gets smaller as you go from here to here (gesture--worms are to be lined up close to S and approximately 10 inches below the apples)."

Correct _____ Incorrect _____

Indicate order S uses _____

E completes or corrects the task if necessary and says, "Now let's match each worm so that it has the right apple to live in. I'll put the biggest worm with the biggest apple" (E places worm in one-to-one correspondence with the apple). "Now you find the smallest worm and put it with the smallest apple." E corrects S if necessary. "Now put each of these worms with the apple that it goes with. (Find the right worm to go with each apple we have left)."

1. Indicate placement of worms -

apples: 1 2 3 4 5 6 7

worms: ___ ___ ___ ___ ___ ___ ___

2. Number placed correctly by S: (Do not count the largest and the smallest worms)

0 1 2 3 4 5 (circle the number)

E completes the task if necessary.

E then extends the array of worms so there is an extra worm at each end of the correspondence. In process of extending worms, E says, "Now all these worms are tired of eating. So they're going to leave the apples for a while. But now, this worm (#4) is getting very hungry again and has to find his apple. Will you help him find his apple?" After S places

worm #4, E puts that worm back in the seriated row of worms. E points to a second worm (#2) and asks, "What apple goes with this worm? They have to be right for each other." (Choose worms: 4, 2, 6). E replaces each worm before asking S to place the next.

	worm no.	apple no.
2a	4	_____
2b	2	_____
2c	6	_____

E mixes the worms up (keeping numbers 1, 6, 3 at the boundary of the group) and says "Now, all the worms are playing over here. But some of them are hungry again. Here's a hungry worm, where is his apple? They have to be right for each other. You can do anything you want with the apples and worms to find out which apple belongs to this worm." (Choose worms: 1, 6, 3). E replaces each worm before asking S to place the next and rescrambles the array if S has altered it.

			Strategy (check where appropriate)		
	worm no.	apple no.	random (guess)	measure	reconstruct series
4a	5	_____	_____	_____	_____
4b	6	_____	_____	_____	_____
4c	3	_____	_____	_____	_____

CONSERVATION

Conservation of Number

Materials: 20 pennies

WARM UP

E constructs two parallel rows of evenly spaced pennies (10 pennies in the row closest to E, 3 pennies in the row closest to S and asks:

"Do the two rows have the same number of pennies?"

Yes No No Response

"Which row has more pennies?"

Correct Incorrect No Response

EQUIVALENCE

Parts (A) and (B) are Counterbalanced

(A) Expansion

E constructs two parallel rows (10 pennies per row) of evenly spaced pennies in the center of the table, making precise perceptual correspondence between the elements of the two rows. E discusses how the rows have the same number of pennies. After S has agreed that they have the same number of pennies, E expands the row nearest to E.

E then asks the following (randomly ordered) questions:

_____ Does this row have just as many (the same number of) pennies as this row?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification:

1. _____

2. (If S says "yes" . . .) _____

_____ Does this row (long one) have more pennies?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification:

1. _____

2. (If S says "yes" . . .) _____

_____ Does this row (short one) have more pennies?

a. Yes _____ No _____ No Response _____ I Don't Know _____

(B) Pennies in a Heap

E reestablishes equivalence with S and then repeats procedure in (A) except one row of pennies is piled in a heap.

_____ Are there just as many (the same number of) pennies here (row) as there are here (heap)?

a. Yes _____ No _____ No Response _____

b. Justification:

1. "How do you know that?" or "How could you tell?" _____

_____

2. (If S says "no," E asks, "How could you make it so they have the same number?" or "Could you do something to make both rows have the same number?") _____

_____

_____ Are there more pennies here (row)?

a. Yes _____ No _____ No Response _____

b. Justification:

1. _____

2. (If S says "yes" . . .) _____

_____Are there more pennies here (heap)?

a. Yes _____ No _____ No Response _____

b. Justification:

1. _____

2. (If S says "yes" . . .) _____

CONSERVATION

Conservation of Weight

Materials: 3 hollow sticks, each 23 cm long. 2 are filled with cotton and weigh 25 g. One is filled with lead shot and weighs 50 g.

WARM UP

E hands the S two 25 gm sticks (1 green, 1 blue) and asks:

"Do these two sticks weigh the same?"

Yes _____ No _____ No Response _____ I Don't Know _____

If S does not say "yes," E and S manipulate sticks and discuss them until both agree they weigh the same. After agreement has been reached, E takes back the sticks and hands S two blue sticks of unequal weight (25 gm and 50 gm). E asks:

"Does one stick weigh more than the other?"

Yes _____ No _____ No Response _____ I Don't Know _____

If child says "yes," E asks, "which one?"

Correct _____ Incorrect _____ No Response _____ I Don't Know _____

If S has difficulty with these questions, E discusses the sticks and the term, "weigh more," until S gets the idea.

EQUIVALENCE

Parts (A) and (B) are counterbalanced

(A) Ball and Pancake

Materials: E has S hold two playdough balls of equal weight and gets S to verbalize this equality. After S has agreed that they weigh the same, E flattens one of the balls into a pancake and asks the following questions (in random order):

_____ Does this piece of playdough (pancake) weigh just as much as this piece (ball)?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification:

1. "How do you know that?" or "How could you know or find out?"

_____

2. If S says "no," E asks "Could you do something so they'd weigh the same?" _____

_____ Does this (ball) weigh more than the pancake?

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. _____

2. (If S says "yes" . . .) _____

_____ Does this pancake weigh more than the ball?

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. _____

2. (If S says "yes" . . .) _____

EQUIVALENCE

Parts (A) and (B) are counterbalanced

(B) Ball and Sausage

E has S hold two playdough balls of equal weight and gets S to verbalize

this equality. E then rolls one of the balls into a sausage and asks the following questions (in random order):

_____ Does the piece of playdough (sausage) weigh just as much as this piece (ball)?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification:

1. "How do you know that?" or "How could you know or find out?"

_____

2. (If S says "no" . . .) _____

_____ Does this (ball) weigh more than the sausage?

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. _____

2. (If S says "yes" . . .) _____

_____ Does this (sausage) weigh more than this (ball)?

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. _____

2. (If S says "yes" . . .) _____

CONSERVATION

Conservation of Area

Materials: 3 green boards (2 are 30 cm x 30 cm; one is 10 cm x 10 cm)

14 "barns" [$(2.5\ cm)^3$ each]

2 plastic toy cows (approx. 3.5 cm high)

WARM UP

E puts 2 green boards on the table (30 cm x 30 cm; and 10 cm x 10 cm) and asks:

"Do these two fields have the same amount of grass for a cow to eat?"

Yes _____ No _____ No Response_____

"Which field has more grass?"

Correct _____ Incorrect _____ No Response _____

"Which field has less grass?"

Correct _____ Incorrect _____ No Response _____

IDENTITY

E displays one green board and places 7 "barns" in a line across one edge of the board and says, "This is a field of grass with lots of barns on it." E places cow on field and says the cow wants to eat the grass. E then scatters the barns randomly on the field and asks the following questions in random order:

_____ Is there still the same amount of grass for the cow to eat as there was before?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification ("How do you know?" or "How could you tell?")

_____

_____ Is there more grass now for the cow to eat?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: _____

_____ Is there less grass now than there was before?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: _____

EQUIVALENCE

E presents the two 30 cm x 30 cm green boards and shows their equivalence by superimposing them. After S agrees that there is the same amount of grass on each, E puts a cow on each field and says: "Now Farmer Jones builds a barn on this field. He has to take some of the grass away to make room for the barn. Now show which cow has more grass to eat. Yes (or No), that (pointing) cow has more grass to eat, because the barn covers up part of this cow's grass. Now I will put a barn on the other field. Now do both cows have the same amount to eat?" (Both barns in the upper left-hand corner).

For both parts (A) and (B) E starts with the board cleared and places the number of barns in each field as specified for each. On the left board, the barns are lined up in one corner of the board. On the right board, they should be scattered in a random pattern. Barns should be placed on each field simultaneously (E uses both hands).

Parts (A) and (B) are Counterbalanced

(A) Three Barns

E says, "Watch what I do. You see, I am putting some more barns in each field." E asks the following questions in random order:

_____ Now does this cow have the same amount of grass to eat as that one?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification:

1. "How could you tell?" or "Could you tell or show me why?"

_____

2. (If S says "no," E asks, "Could you make it so they both have the same amount of grass to eat?") _____

_____ Does this cow (barns in a row) have more to eat than this one?

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. _____

2. (If S says "yes" . . .) _____

_____ Does this cow (barns scattered) have more to eat than this one?

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. _____

2. (If S says "yes" . . .) _____

(B) Seven Barns

E removes barns from both fields and says, "Now some new farmers want to build barns on these fields. Farmer Smith puts one barn on his field so I put one on this other field. Everytime he puts one on his field, I put one on this other field." E places 7 blocks in a line on Farmer Smith's field and 7 blocks scattered on the other field. E then asks the following randomly ordered questions:

_____ Does this cow have as much (the same amount) to eat as that one?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification:

1. "How could you tell?" or "Could you show me why?"

_____

2. (If S says "no," E asks "Could you make it so they both have the same amount of grass to eat?") _____

_____ Does this cow (barns in a row) have more to eat than this one?

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. _____

2. (If S says "yes" . . .) _____

_____ Does this cow (barns scattered) have more to eat than this one?

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. _____

2. (If S says "yes" . . .) _____

CONSERVATION

Conservation of Length

Materials: Picture of unequal parallel lines

Two 28.0 cm lengths of string

Two pieces of gold felt

WARM UP

E shows S a picture of two unequal parallel lines (10 cm and 20 cm, respectively) and asks:

"Are the two lines the same length?"

Yes _____ No _____ No Response _____

"Which line is longer?"

Correct _____ Incorrect _____ No Response _____

EQUIVALENCE

(A) Circular Deformation

E places two lengths of string parallel to one another on the piece of felt and says, "See, these are the same length. After S agrees that they are the same length, E changes the string closest to E to a circle and

asks each of the following questions in random order:

_____ Is this string just as long as this string? (E runs finger along length of each.)

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification:

1. "How do you know that?" or "How did you decide that?" or "Can you show me how you know that?" etc. _____

(If S gives no response or says "I don't know" in part A, E asks, "How would you decide?")

2. (If child says "no," E asks, "What could you do so that they'd be the same length?" _____

_____ Is this string (straight one) longer than this string (circle)?

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. _____

(If S gives no response [in part A] E asks "How would you decide?" or "How could you find out?")

2. (If child says "yes" . . .) _____

_____ Is this string (circle) longer than this string (straight one)?

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. _____

2. (If S says "yes" . . .) _____

(B) Right-Left Deformation

E places the 2 lengths of string parallel to one another on the piece of felt and says, "See, these are the same length. Now I'm going to move

one over here" (E moves string closest to E 14 cm to S's left). E asks each of the following questions in random order:

_____ Is this string just as long as this string? (E runs finger along length of each)

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification:

1. ("How do you know that?" or "How did you decide that?" or "Can you show me how you know that?" etc.) _____

_____

(If S gives no response or says "I don't know" [in part A] E asks, "How would you decide?")

2. (If S says "no" E asks, "What could you do so they'd be the same length?") _____

_____ Is this string (closest to S) longer than this string (closest to E)?

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. _____

(If S gives no response [in part A] E asks "How would you decide?" or "How could you find out?")

2. (If S says "yes" . . .) _____

_____ Is this string (closest to E) longer than this string (closest to S)?

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. _____

2. (If S says "yes" . . .) _____

CONSERVATION

Conservation of Interior Volume

WARM UP

Materials: 2 Lego block "houses" 2 are 1 x 2 x 3 (Configuration 1), 1 is red, one is white; 1 is 3 x 4 x 3 (12 blocks), red

E places red 1 x 2 x 3 house and the 3 x 4 x 3 house on the table.

E asks:

"Do these 2 houses have the same amount of space inside?"

Yes _____ No _____ No Response _____

"Which house has more space inside it?"

Correct _____ Incorrect _____ No Response _____

"Which house has less space inside it?"

Correct _____ Incorrect _____ No Response _____

E places two 1 x 2 x 3 houses on the table

"Do these 2 houses have the same amount of space inside?"

Yes _____ No _____ No Response _____

"Does one of the houses have more space inside it?"

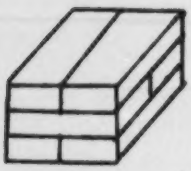
Yes _____ No _____ No Response _____

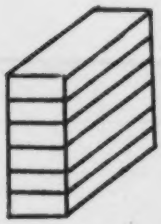
If S says there is more space in one of the houses, E and S discuss the size (i.e., amount of space) of the houses until they agree that the houses do have the same amount of space inside.

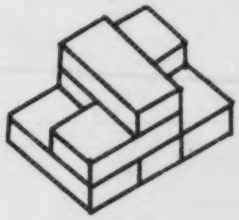
Conservation of Interior Volume

Materials: 2 houses--1 red "house" made up of 6 interlocking Lego blocks
1 white "house" made of 6 interlocking Lego blocks

Configuration 1 Configuration 2 Configuration 3







IDENTITY

E places red house (of dimensions 1 block x 2 blocks x 3 blocks) on the table. E then transforms the house into configuration 3 and stresses that all the same blocks are being used. E asks (randomly ordered):

_____ Is there the same amount of space inside the house now as there was before?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: How do you know that?_____

_____ Is there more space inside the house now than there was before?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: How do you know that? _____

_____ Is there less space inside the house now than there was before?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: _____

EQUIVALENCE

E places 2 houses (one red, one white) on the table. E converses about building houses on the land. The dimensions of the houses are quantitatively and perceptually equivalent (1 x 2 x 3). E establishes with S that there is the same amount of space inside each house. Parts (A) and (B) are counterbalanced.

(A) Configuration 2

E starts with both houses in configuration 1 (1 x 2 x 3). E transforms the white house and makes conversation about "remodeling" the house. E should emphasize that all the same blocks will be used in the "remodeled" house. E asks (randomly ordered):

_____ Is there the same amount of space inside the red house as in the white house? (points to each one)

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification:

1. "How do you know?" or "How could you tell?" _____

2. If S says no, E asks, "How could you make it so they have the same space inside?" _____

_____ Is there more space inside the red house than in the white house? (E points to the appropriate houses)

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. _____

2. (If S says "yes" . . .) _____

_____ Is there more space inside the white house than in the red house? (E points to appropriate houses)

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. _____

2. (If S says "yes" . . .) _____

EQUIVALENCE

E places 2 houses (one red, one white) on the table. E converses about building houses on the land. The dimensions of the houses are quantita-

tively and perceptually equivalent (1 x 2 x 3). E establishes with S that there is the same amount of space inside each house. Parts (A) and (B) are counterbalanced.

(B) Configuration 3

E starts with both houses in configuration 1 (1 x 2 x 3) and establishes the equality of the houses. E then transforms the white house into configuration 3 and stresses that all the same blocks will be used in the remodeled house. E asks (randomly ordered):

_____ Is there the same amount of space inside the red house as in the white house? (E points to each one)

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification:

1. "How do you know?" or "How could you tell?" _____

2. If S says "no," E asks, "How could you make it so they have the same space inside?" _____

_____ Is there more space inside the red house than in the white house? (E points to the appropriate houses)

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. _____

2. (If S says "yes" . . .) _____

_____ Is there more space inside the white house than in the red house? (E points to appropriate houses)

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. _____

2. (If S says "yes" . . .) _____

CONSERVATION

Conservation of Occupied Volume

WARM UP

Materials: 2 glass beakers, 250 ml ("jars")

1 red house made of 12 Lego blocks (3 x 4 x 3)

E shows S the 2 empty jars, asks S to put his hand in and feel the spaces in each jar. E then puts the "house" in one jar and discusses the lesser amount of space in the jar now. E asks the following randomly ordered questions:

_____ If I wanted to fill both jars with water, could I get (the same amount of) just as much water in this jar (empty) as in this jar (with "house")?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: "How do you know?" or "How could you tell?"

_____

_____ Could I get more water in this jar (with the "house") than in this one (empty)?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: _____

_____ Could I get more water in this jar (empty) than in this one (with "house")?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: _____

IDENTITY

Materials: same as for warm up but large house is replaced by a red house made of 6 blocks (Configuration 1)

"Pretend"

E says, "Now suppose I put this house into the jar and let's pretend that I fill it up with water. But I decide I want to remodel the house, so I pour the water out." E goes through the motions. "We have to use all the same blocks in making our new house. Let's make it tall and skinny like this." (E transforms house to configuration 2). "I put the house back into the jar and 'fill' the jar up to the top with water again." E goes through motions. E asks the following questions in random order:

_____ Could I fit just as much water in here this time as I could before? (before we remodeled the house or before we made the house tall and skinny)?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: "How do you know?" or "How could you tell?" or "How did (could) you figure that out?" _____

_____ Could I fit more water in the jar now than I could before? (before we remodeled the house or before we made the house tall and skinny)?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: _____

_____ Could I have fit more water in the jar before when the house was a different shape than I can now? (before we remodeled the house or before we made the house tall and skinny?)

a. Yes _____ No _____ No Response _____ I Don't Know _____

EQUIVALENCE

Parts (A) and (B) are Counterbalanced

Materials: 2 houses each made of 7 Lego blocks: 1 house of red blocks
1 house of white blocks

2 identical transparent containers ("jars")

(A) Configuration 2

E shows S the 2 houses, each in configuration 1, and establishes equivalence (same size, number of blocks, etc.). E then puts the red house in one jar. E transforms the white house into configuration 2 and says, "I'm going to remodel this house and I have to make sure I use all the same blocks while I do it." E then places the remodeled white house in the second jar, and says, "Let's pretend that I fill this jar up with water and this jar with water (E points to jars). E asks the following questions in random order:

_____ Could I fit just as much water in this jar (E points to jar with white house) as in this jar (jar with red house).

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: "How could you tell?" or "How did you figure that out?", etc. _____

_____ Could I fit more water in this jar (with white house) than in this one (with red house)?

a. Yes _____ No _____ No Reponse _____ I Don't Know _____

b. Justification: _____

_____ Could I fit more water in this jar (with red house) than in this one (with white house)?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: _____

EQUIVALENCE

Parts (A) and (B) are Counterbalanced

Materials: 2 houses each made of 6 Lego blocks: 1 house of red blocks
1 house of white blocks

2 identical transparent containers ("jars")

(B) Configuration 3

With both houses in Configuration 1, E and S establish equivalence. E puts the red house in one jar, and then discusses the remodeling of the white house. E transforms the white house into configuration 3 and points out the need to use all the blocks. E then places the white house in the second jar and says, "Now let's pretend again. Let's pretend we fill both jars with water." E asks the following randomly ordered questions:

_____ Could I fit just as much water in this jar (E points to jar with white house) as in this jar (jar with red house)?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: "How could you tell?" or "How did you figure that out?", etc. _____

_____ Could I fit more water in this jar (with white house) than in this one (with red house)?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: _____

_____ Could I fit more water in this jar (with red house) than in this one (with white house)?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: _____

CONSERVATION

Conservation of Displacement Volume

Materials: 2 houses--1 red "house" made up of 6 interlocking Lego blocks
1 white "house" made up of 6 interlocking Lego blocks

IDENTITY

E puts out a single jar and the red house. E pours water into the jar

(to the 350 ml level) and uses the red pen to mark the water level. E then places the red (configuration 1) house in the water and indicates the new water level with the blue marking pen. The house is removed from the water and transformed into configuration 3. E asks the following questions (randomly ordered):

_____ If I put the house back into the water, will the water come up to this level (E indicates blue mark on jar)?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: How do you know that? _____

_____ If I put the house back into the water, will the water come up higher than this blue mark?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: How do you know that? _____

_____ If I put the house back into the water, will the water be lower than this blue mark?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: How do you know that? _____

EQUIVALENCE

E fills two jars with water to the same level (to the 350 ml mark). Water levels are marked with the red pen. The houses are of the same configuration (1 block x 2 blocks x 3 blocks). E places one house in each jar of water and establishes with the child that the water comes up to the same level in both jars. New lines are drawn in blue to indicate the new level. E then removes the "houses" from the water and erases the lines. E and S then reestablish the equality of the water levels and mark the levels in red. A and B are counterbalanced.

(A) Configuration 2

E transforms the white house into configuration 2, verbalizing the actions

in the process. E then puts the red house into one jar and makes a blue line at the new level, verbalizing his actions as he goes through them. E asks (randomly ordered):

_____ If I put the white house in this jar of water, will this water (E indicates appropriate jar) come up just as high as it is over here?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification:

1. How do you know that? _____

2. If S says 'no,' "What could you do so they'd make the water the same in each jar?"_____

_____ If I put the white house in this jar of water, will this water (E indicates appropriate jar) be higher than this water (E indicates jar containing red house)?

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. How do you know that? _____

2. (If S says "yes" . . .) _____

_____ If I put the white house in this jar of water, will this water (E indicates appropriate jars) be lower than this water (E indicates jar containing red house)?

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. How do you know that? _____

2. (If S says "yes" . . .) _____

E asks: If I put the white house into this jar of water, how high will the water come? Point with you finger. Correct _____ Incorrect _____

E has S put the white house into the jar and comments on the result. E

then removes both houses from their jars and transforms them back into configuration 1.

EQUIVALENCE

E fills two jars with water to the same level (to the 350 ml mark). Water levels are marked with the red pen. The houses are of the same configuration (1 block x 2 blocks x 3 blocks). E places one house in each jar of water and establishes with the child that the water comes up to the same level in both jars. New lines are drawn in blue to indicate the new level. E then removes the "houses" from the water and erases the lines. E and S then reestablish the equality of the water levels and mark the levels in red. A and B are counterbalanced.

(B) Configuration 3

E transforms the white house into configuration 3. E then puts the red house into one jar and marks the water at the new level (in blue), verbalizing the actions. E asks (randomly ordered):

_____ If I put the white house in this jar of water, will this water (E indicates appropriate jar) come up just as high as it is over here?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification:

1. How do you know that? _____

2. If S says 'no,' "What could you do so they'd make the water the same in each jar?" _____

_____ If I put the white house in this jar of water, will this water (E indicates appropriate jar) be higher than this water (E indicates jar containing red house)?

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. How do you know that? _____

2. (If S says "yes" . . .) _____

_____ If I put the white house in this jar of water, will this water (E indicates appropriate jar) be lower than this water (E indicates jar containing red house)?

a. No _____ Yes _____ No Response _____ I Don't Know _____

b. Justification:

1. How do you know that? _____

2. (If S says "yes" . . .) _____

E asks: If I put the white house in this jar of water, how high will the water come? Point with your finger. Correct _____ Incorrect _____

E has S put the white house into the jar and comments on the result. E then removes both houses from their jars and transforms them back into configuration 1.

INTERIM TASKS

(short-term summative assessment)

Name _____

SPONTANEOUS CLASSIFICATION

Materials: 1. _____

2. _____

E discusses with S the materials. Individual items are named. E then asks:

1. Can you put these _____ into groups?

   1st Criteria used: (a) _____ 2nd C. (a) _____
   (b) _____ (b) _____
   (c) _____ (c) _____

   (If S uses idiosyncratic criteria, or organizes items into super-ordinate groups, E asks:)

2. Can you put these _____ into (No.) groups?

   1st Criteria used: (a) _____ 2nd C. (a) _____
   (b) _____ (b) _____
   (c) _____ (c) _____

   (If S does not use criteria for grouping items according to commonly accepted nesting structure of sub-groups, E selects and identifies ONE examplar for each sub-group. E then asks:)

3. Can you find any other _____ to put with these?

   OR

   Can you find any other _____ to put with this (now this _____, and this _____--identifying each exemplar)?

   Scoring: _____ COMPLETE 1a 1b 2a 2b 3a 3b
   PARTLY COMPLETE 1a 1b 2a 2b 3a 3b
   OTHER 1a 1b 2a 2b 3a 3b

(Short-term summative assessment)

Name _____

CLASS INCLUSION

Materials: (3 sub-groups) _____

ALL and SOME

E discusses _____ with S, then asks:

1. Look at ALL the _____; are ALL the _____?

   Yes _____ No _____ Other _____

2. Look at ALL the _____; are ALL the _____?

   Yes _____ No _____ Other _____

3. Look at ALL the _____; are ALL the _____?

   Yes _____ No _____ Other _____

4. Look at ALL the _____; are ALL the _____?

   Yes _____ No _____ Other _____

Class Inclusion/3

CLASS INCLUSION B (3 sub-groups) twice

E shows S all the _____

and says, "Here are some 'E.' They are ALL 'E,' but some are 'A' and some are 'B' and some are 'C.'

(Place 'A', 'B,' and 'C' near each other).

Let's see how many 'D' we have (i.e., 'A' + 'B') - (count).

Let's see how many 'E' we have (i.e., 'A' + 'B' + 'C') - (count).

1. Are there more ('A', or 'B,' or 'C') or more 'E'?

   Response _____

   Question for justification _____

   (When you say there are more _____ than _____ which are the _____ and which are the _____?)

2. Are there more 'E' or more ('A', or 'B,' or 'C')?

   Response _____

   Question for justification _____

3. Are there more 'D' or more 'E'?

   Response _____

   Question for justification _____

4. Are there more 'E' or more 'D'?

   Response _____

   Question for justification _____

5. Are there more 'D' or more ('A,' or 'B')?

   Response _____

   Question for justification _____

6. Are there more ('A' or 'B') or more 'D'?

Response _____

Question for justification _____

NOTE: E = Animals

D = Animals that live on the land

C = Fish

B = Birds

A = Mammals

(Short-term summative assessment)

CONSERVATION OF AREA A.

Materials: TABLES (Materials are two brown colored boards to represent table-tops. There are six equal area 'plates.' Each 'table' measures 20 cm x 20 cm.)

IDENTITY

E displays one 'table-top' and places six 'plates' in a line across one edge of the 'table.' E says, "This is a table with lots of plates on it. Part of the table is not covered by the plates (pointing). E then scatters the plates randomly on the table and asks the following questions in random order:

_____ Can you still see the same amount of table-top as you could see before?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification ("How do you know?" or "How could you tell?")

_____

_____ Can you see more of the table-top now?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification _____

_____ Can you see less of the table-top now?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification _____

EQUIVALENCE

E presents the two 30 cm x 20 cm table-tops and shows their equivalence by superimposing them. After S agrees that there is the same amount of table-top on each table, E says, "We are putting a plate on this table. Now point to the table which has the most table-top showing. Yes (or No),

that table has the most table-top showing. Now we are putting a plate on the other table. Now do both the tables have the same amount of table-top showing? (Both plates are placed in the upper right hand section of the table.) Yes, both tables have the same amount of table-top showing.

Part A

E says, "Watch what I do. You see. I am putting some plates on each table-top." (E places three plates next to each other down one side of one of the tables. Three plates are randomly placed on the other table-top). E asks the following questions in a random order:

_____ Do you see the same amount of table-top on this table as on that table?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification _____

_____ Does this table-top (plates in a row) have more table-top showing than this one (plates randomly distributed)?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification _____

_____ Does this table-top (plates scattered) have more table-top showing than this one (plates in a row)?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification _____

Part B

E removes plates from both table-tops and says, "Now we are going to put some more plates on these table-tops. I am going to put one plate on this table, and now I shall put a plate on this table. Everytime I put a plate on this table I shall also put a plate on this table." (E

places six plates in a line down the side of one table and six plates scattered on the other table. E then asks the following questions in a random order):

_____ Can you see as much table-top on this table as that one?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification _____

_____ Does this table (plates in a row) have more table-top showing than this one (plates scattered)

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification _____

_____ Does this table (plates scattered) have more table-top showing than this one (plates in a row)?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification _____

CONSERVATION OF AREA B.

Materials: Grassed yard. (Materials are two green colored boards made up of six equal area squares to represent grassed yards. Each 'grassed yard' measures 30 cm x 20 cm made up of six squares measuring 10 cm x 10 cm).

IDENTITY

E displays one of the 'grassed yards' and places a 'grass-mower' at one corner of the grassed yard. E says, "This is a grassed-yard and the man has to mow the grass with this grass-mower." E then moves one of the center 'grass-squares' so that it lies outside the grassed yard with one edge in line with the outside edge of the grassed yard. E says, "The man moved this piece of grass to here (pointing). He planted a tree in this space." (E places a tree in the space previously occupied by the grassed square). E then asks the following questions in a random order:

_____ Is there still the same amount of grass for the man to mow as there was before?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification _____

_____ Is there more grass for the man to mow now?

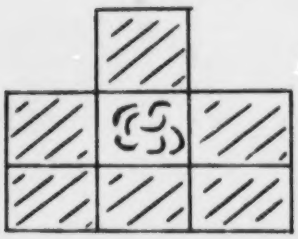
a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification _____

_____ Is there less grass for the man to mow now?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification _____

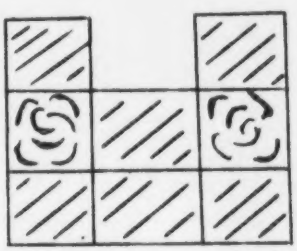


EQUIVALENCE

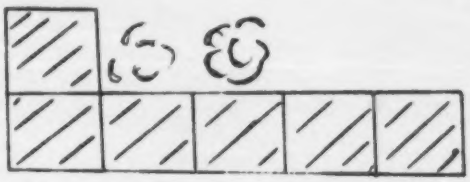
E presents the two 30 cm x 20 cm grassed yards and shows their equivalence by superimposing them. After S agrees that there is the same amount of grassed yard E says, "We are taking away this piece of grassed yard (E removes the top center section piece). Now point to the grassed yard which has the most amount of grass. Yes (or No), that grassed yard has the most amount of grass. Now we are taking away this piece of grassed yard (E takes away the top center piece in the second grassed yard). Now do both the grassed yards have the same amount of grass? Yes, both grassed yards have the same amount of grass.

Part A

E says, "Watch what I do. You see, I am moving some pieces of grass in each grassed yard." (E places the two outside, top pieces of grass so that they lie above the top outside edge of the grassed yard with their lower edges in line with the top edge of the remaining piece of grass: grassed yard (a).



E places the two top right hand side pieces of grass in line with, and to the right hand side of the three bottom pieces of grass; grassed yard (b).



E says, "The man is going to plant trees where the pieces of grass used to be. (E places two trees in each previously occupied grassed area for both grassed yards, respectively.) The man is now going to mow the grass in each of the two grassed yards." E then asks the following questions in a random order:

_____ Do you think the man has to mow the same amount of grass in this yard (pointing) as in this yard (pointing)?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: _____

_____ Does this man have to mow more grass in this yard (a) as in this yard (b)?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: _____

_____ Does this man have to mow more grass in this yard (b) as in this yard (a)?

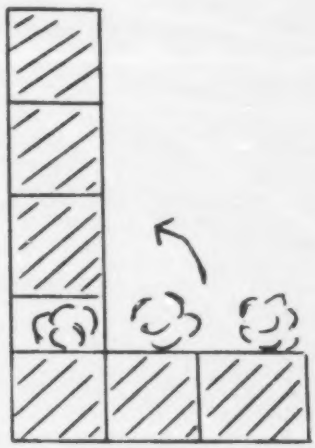
a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: _____

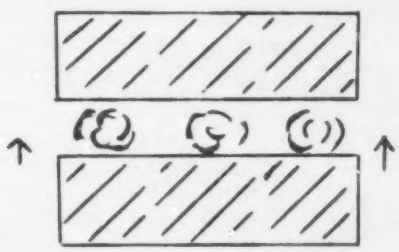
Part B

E removes the trees and replaces the pieces of grass to their original 30 cm x 20 cm configuration. E says, "I am going to move one piece of grass in this yard, and now I am going to move one piece of grass in

this yard. Everytime I move one piece of grass in this yard I shall also move one piece of grass in this yard." (E places three pieces of grass in yard (a) in the following configuration):



E places three pieces of grass in yard (b) in the following configuration:



E says, "The man is going to plant trees where the pieces of grass used to be. (E places three trees in each previously occupied grassed area for both grassed yards respectively.) The man is now going to mow the grass in each of the two grassed yards." E then asks the following questions in a random order:

_____ Do you think the man has to mow the same amount of grass in this yard (pointing) as in this yard (pointing)?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: _____

_____ Does the man have to mow more grass in this yard (a) as in this yard (b)?

a. Yes _____ No _____ No Response _____ I Don't Know _____

b. Justification: _____

_____ Does the man have to mow more grass in this yard (b) as in this yard (a)?

a. Yes _____ No _____ No Response _____ I Don't Know _____

CONSERVATION TASK JUSTIFICATIONS (EXPLANATIONS):

TYPES OF RESPONSES

Conservation Task Justifications (Explanations)

TYPE OF RESPONSE	DESCRIPTION AND EXAMPLES OF REPRESENTATIVE RESPONSES
Inversion	Child verbalizes and/or demonstrates that the two stimuli are the same if the transformed object(s) are returned to original form. e.g.: "You could move the string back like this." S puts pennies from pile or extended row back into line. N.B. Cons. area: S puts scattered barns into a line on equivalence tasks. Cons. vol.: (all tasks) S puts transformed house back into original shape.
Reciprocity	Child verbalizes and/or demonstrates that the two stimuli are the same if the untransformed (standard) object(s) is(are) changed to match the other. e.g.: "Make them both into pancakes." N.B. Cons. area: S scatters barns on equivalence tasks. Cons. vol.: (all tasks) S changes standard to match transformed house.
Reciprocity/ Inversion	Child gives a verbal or nonverbal response which could be either reciprocity or inversion; tester's transcript leaves it ambiguous. e.g.: "When you put them together, they're the same." "Move them closer"--for cons. length (not for no.) S lines them up parallel.
Compensatory Relations	Child verbalizes that a decrease in one dimension of the transformed stimulus can be compensated by an increase in the other dimension or vice versa so that it remains equal to the standard stimulus. e.g.: "It's wider, but it's flatter." "Well, it's wider so it's bigger but if you make it a little flatter, it would be the same.

TYPE OF RESPONSE	JUSTIFICATION (cont)
Addition/ Subtraction	Child verbalizes and/or demonstrates that: a) since nothing has been added to or subtracted from either stimulus, they remain equal on the relevant dimension or b) if some amount were added to or subtracted from one of the stimuli, the two would be the same on the relevant dimension or c) S counts the number of items in each row (group) and indicates a comparison--or S may simply show a 1-1 correspondence. e.g.: Child moves a penny from the standard row to the transformed row or vice versa. Child divides the transformed ball of clay in half. "You didn't put any more on." S counts the number of barns on each field--"There's 7 and there's 7." Cons. area: S moves barns from 1 field to the other. Cons. area: S removes barns from 1 field only. Cons. area: S stacks barns on field(s) Cons. area: "Cause they are both 3." Cons. area: S shows 1-1 corresp.--"every time you put 1 there you put 1 there." Cons. no.: "They each have a partner." Cons. wt.: "They both have the same much of playdough." Area, vol. (identity): "There are still 6 blocks." N.B. Cons. vol.: occupied displaced: S must indicate relation between number of blocks and space occupied (or H_2O that can fit around) or S must indicate relation between space added or subtracted to house and the amount of H_2O that can be added (or the height of the H_2O level).

TYPE OF RESPONSE	JUSTIFICATION (cont)
Addition/ Subtraction (cont)	e.g.: "There's the same amount of bricks so the same amount of water goes in." "There's the same amount of space."
Statement of Operations	Child verbalizes that the shape of the stimulus has been changed but that the transformed stimulus is still the same on the relevant dimension. or S claims that the change in the stimulus alters the relevant dimension. e.g.: "They're still the same." "You just changed..." "All you did was..." "You only..." "It doesn't matter if you..." "Because those are just spread out." "They are the same long because before they were the same long." (S indicates appropriate dimension and uses past tense.) Cons. length (not no.) "When you move it, you make it longer." (no reference to reversibility) *Cons. area: "Yours took more room than mine." "Because there were more when it was in a row." "This cow has more to eat because we lined these up." *N.B. These would not count as justification for tasks other than conservation area. Cons. interior volume "When it's bigger, it has more space." "When you moved it, you made it bigger." *Cons. occupied & displaced volume S must indicate relationship between size or space of house and amount of water (or space around house). "More water when it was a square." "This is flatter; the red takes up more room." "Cause it's flat, and not very much water can go in there."

TYPE OF RESPONSE	JUSTIFICATION (cont)
Statement of Operations (cont)	*N.B. These are more stringent criteria than for conservation of interior volume.
TYPE OF RESPONSE	NO JUSTIFICATION
Inversion Reciprocity Inversion/ Reciprocity	"Get them the same." "Make them the same." S stacks up one or both groups of pennies.
Addition/ Subtraction	Cons. number: S counts each row (group) but does not indicate a comparison of one number to the other. Cons. area: "Because I counted them." S removes all barns from both fields. "You put one barn here and one barn here." (S fails to mention that this was repeated each time.)
	Cons. vol. (all): "same blocks" "You used the same blocks." (E has just stated this.) identity task--S states "There are 6 blocks" but does not indicate that number of blocks hasn't changed in the transformation. S indicates that amount space is the same if neither jar has a house in it. *Cons. occupied volume: "You didn't add any blocks or take any away." (S fails to mention relation between number of blocks and space occupied or left unoccupied.) *N.B. only for occupied volume
Operations	Descriptions of the stimuli: "This is long (short)." "This is longer (shorter)."

TYPE OF RESPONSE	NO JUSTIFICATION (cont)
Operations (cont)	"This is long and this is short" or the equivalent of this. Descriptions of the transformation: "You changed the shape." "You split them apart." "Before they were right out." "They used to be like that row." Cons. number "They have the same amount because they were the same size before." Cons. area "There's still the same amount." (Can't tell if S means grass or barns.) Cons. volume "Cause you make it bigger." (S doesn't mention what effect this has.) "When they were all rolled up, they were the same." (Can't tell what dimension S is referring to.)

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